VSB – TECHNICAL UNIVERSITY OF OSTRAVA
FACULTY OF ECONOMICS

DEPARTMENT OF FINANCE

# Aplikace metodologie CorporateMetrics pro kvantifikaci tržního rizika ve společnosti British Airways

# CorporateMetrics Methodology Application for the Market Risk Quantification in British Airways Company

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# Diploma Thesis Assignment

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1. Introduction
2. Description of the CorporateMetrics Methodology
3. Characterization of British Airways Company
4. Application of the CorporateMetrics Methodology and Comments on Results
5. Conclusion

Bibliography
List of Abbreviations
Declaration of Utilisation of Results from the Diploma Thesis
List of Annexes
Annexes

References:

DLUHOŠOVÁ, Dana et al. *Financial Management and Decision-making of a Company. Analysis, Investing, Valuation, Sensitivity, Risk, Flexibility.* SAEI, vol. 28. Ostrava: VSB-TU Ostrava, 2014. ISBN 978-80-248-3619-5.
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# Content

# 1. Introduction

In the context of rapid economic development, the global economic is closely linked. Our targeted Corporation is British Airways, as an international company, there are many risks associated with their business, especially the risk from foreign trade market. The risk will influence the decision making, planning and profit of our chosen company.

The aim of this thesis is to apply CorporateMetrics Methodology to predict net operating profit of British Airways in year 2019 under different market risks. The historical reports are from 2013 to 2017, the report 2018 is not available for now.

There are five chapters of our diploma thesis.

In chapter 2, the main aim is to introduce the basic principle of CorporateMetrics Methodology. There are 5 parts of this chapter: basic principle of CorporateMetrics Methodology, CorporateMetrics Methodology applied with corporations, modelling for prediction, estimation of net operating profit and frequency distribution analysis with specific procedure and formula equations.

In chapter 3, we will introduce our target corporation British Airways in their basic information which contained 4 parts: overview, the history of British Airways, financial conditions and SWOT analysis.

Chapter 4 is the practical part of our thesis, which has the largest proportion among the whole thesis. In chapter 4, we will combine the principle of CorporateMetrics Methodology in chapter 2 and our historical data from internet and British Airways' annual reports to make prediction of Jet Fuel market price, Passengers carried and Exchange rate USD/GBP and estimate the net operating profit of British Airways in year 2019 plus sensitivity analysis of it.

The last chapter 5 is the conclusion. It is based on the historical value and predicted value from chapter 4 to summarize the whole thesis.

# 2. Description of the CorporateMetrics Methodology

The aim of this chapter is to describe the theoretical principle of our thesis in CorporateMetrics Methodology, and combine the reality of British Airways to introduce the process of net operating profit prediction. There are 5 parts in chapter 2.

## 2.1 Basic principle of CorporateMetrics Methodology

This part we will introduce the framework of CorporateMetrics Methodology. The aim of RiskMetrics Group is to make risk management methodologies.

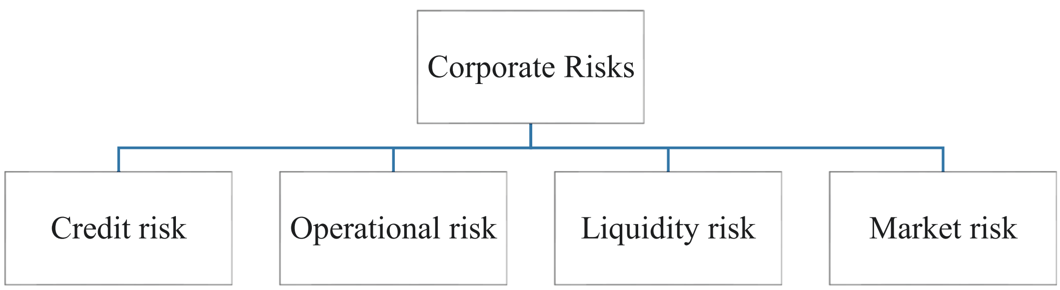
### 2.1.1 Background of CorporateMetrics Methodology

Conducting business activities in a global and increasingly liberalized trade environment, which brought numerous risks for corporations, the growing number of hedging alternatives and financing strategies intensified market competition and challenges. CorporateMetrics Methodology is provided to measure the market risk due to the fact that corporations are less sensitive to daily market moves and focus more on longer term fluctuations.

### 2.1.2 Measuring market risk for corporations

We define risk as the level of uncertainty on future net profits. The uncertainty occurs from many sources, the common classification of risks can be shown in following Figure 2.1.

*Figure 2.1 Common classification of corporation risks*




(Source: LEE, Alvin. CorporateMetrics Technical Document [online]. New York: RiskMetrics Group, J. P. Morgan, 1999. [2017-08-04].)

In Figure 2.1 we have a briefly look of corporate risks classification. In more details, Credit risk estimates the potential loss because of the inability of a counterparty to meet its obligations, Operational risk results from errors that can be made in instructing payments or settling transactions. Liquidity risk is reflected in the inability of a firm to fund its illiquid assets. Market risk, involves the uncertainty of future earnings resulting from changes in market conditions, (e.g., prices of assets, interest rates).

According to the characteristics of each market risk we will apply CorporateMetrics Methodology to solve the problem of it. However, each market risk changes with different path, we need to target correlative method to measure the risk.

### 2.1.3 Methodology applied for market risk

According to the risk we measured, the applied methodologies of CorporateMetrics for risk measurement are: Earnings-at-Risk (EaR), Earnings-per-share-at-Risk (EPSaR) and Cash-Flow-at-Risk (CFaR). Based on the specific objective, we will choose the historical data from the report of the corporation to decide the appropriate method for calculating parameters and prediction

### 2.1.4 Monte Carlo Simulation

Furthermore we will apply appropriate method and estimate correlated parameters to make long-term forecasting and scenario generation to accomplish the measurement of risk. Monte Carlo methods are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results. Their essential idea is using randomness to solve problems that might be deterministic in principle. The most important procedure is to generate scenarios in Monte Carlo. It will use random variables to simulate the values by specific function to construct probability process, moreover implement sampling from known probability distributions then establish the estimation.

## 2.2 CorporateMetrics Methodology applied with corporations

In this part, we will combine the theoretical part of chapter 2.1 with the real condition of our objected company British Airways Corporation to apply CorporateMetrics Methodology.

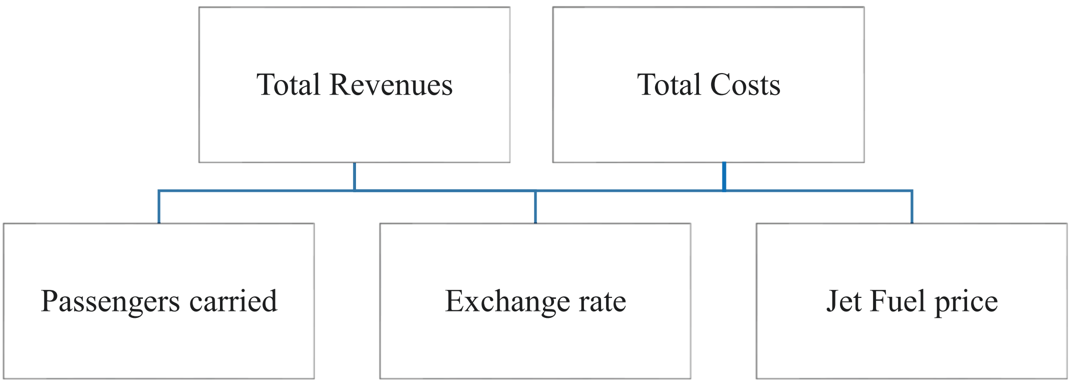
### 2.2.1 Measurement selection

According to the corporation that we choose is an Airways company, so we decide to select the measurement of Earnings-at-Risk (EaR), which means the amount of earnings in British Airways Corporation will be influenced by different level of market risks.

### 2.2.2 Market risk estimation

As an international airways company, the business of British Airways is exposed to numerous risks. According to the measurement we choose is Earnings-at-Risk (EaR), the random variables which will influence earnings from each link can be shown as following Figure 2.2.

*Figure 2.2 Measured risks connected with the objected company*




From Figure 2.2 we can see the relationship of our earnings with risks, where NOP is net operating profit, R is total revenue and TOC is total operating cost. In the procedure of measure our earnings, the total revenue will be influenced by the change quantity of Passengers carried and Exchange rate USD/GBP where air ticket by USD (United States Dollars) besides GBP (Great Britain Pound). The total costs can be influenced by Fuel cost, which is connected with Jet Fuel price and the value paid for it is involved with Exchange rate USD/GBP. So the measured market risks of our target company is Passengers carried, Exchange rate USD/GBP and Jet Fuel price.

### 2.2.3 Simulation evolution with scenarios

Based on the historical value of our measured market risk, we will apply correlative methods in prediction of each random risk from CorporateMetrics Methodology. Based on the long run horizon of prediction, there are 1000 scenarios will be used by applying Random Number Generation to obtain 1000 random numbers for a prespecified probability distribution. The output of predicted random variables will be transformed into our financial result: Earnings-at-Risk (EaR) as predicted net profit in year 2019.

### 2.2.4 Probability distribution

The last step is to make probability distribution by applying function "FREQUENCY" to figure out the most frequent probability of our predicted earnings, and put them into graph with three-dimensional figures to analyse, next we will make the characteristic output table for the target value and make the sensitivity analysis for each risk to see their influence to the company's earnings.

## 2.3 Modelling for prediction

The aim of this part is to describe the specific methods that will be applied for our prediction. According to the character in the historical data of each target value, there are four methods that will be applied in our prediction: Geometric Brownian motion, Vašíček model, weighted average method and simple average method. These methods will help us modelling the simulation.

### 2.3.1 Geometric Brownian motion

The random market variables are typical by their random evolution in time. The random evolution of variable in time is referred to as the stochastic process. In principle, any stochastic process can be described either discretely or continuously. Geometric Brownian motion

(GBM)[1] is a continuous-time stochastic process in which the logarithm of the randomly varying quantity follows a Brownian motion (also called a Wiener process) with drift.

This model can help with the simulation of stock prices, exchange rates, Jet Fuel prices and so on. The most important is that the stochastic process of the index must follow GBM if it satisfies following stochastic differential equation, the arithmetic Brownian motion in logarithmic value is defined by

$$\mathrm{dx} = \mu \cdot \mathrm{dt} + \sigma \cdot \mathrm{dz} \tag{2.1}$$

In equation (2.1) the parameters are constant and independent on other variables which is straightforward with a linear trend. The geometric Brownian motion can be defined also by

$$\mathrm{dx} = \mu \cdot \mathrm{x} \cdot \mathrm{dt} + \sigma \cdot \mathrm{x} \cdot \mathrm{dz} \tag{2.2}$$

In our thesis, the most important type of Brownian motions is the one of (2.2) applied on continuous value of $S$.

$$S_T = S \cdot e^{\mu} \tag{2.3}$$

Further, the continuous average logarithmic value $\mu$ is given by

$$\mu = \ln \frac{S_T}{S} \tag{2.4}$$

We combine formula (2.2) and (2.4) to generate our average value drift α, where σ is standard deviation

$$\alpha = \mu - \frac{\sigma^2}{2} \tag{2.5}$$

The variance $\sigma^2$ and σ standard deviation can be calculated in Excel by

$$\sigma^2 = VAR.P \tag{2.6}$$

$$\sigma = \mathrm{STDEV.P} \tag{2.7}$$

According to the value $S$ is lognormally distributed, which logarithm is distributed normally, so we can get the formula of random evolution of the value $S$

$$\mathrm{S}_t = S_{t-1} \cdot \exp(\alpha \cdot \sqrt{\Delta \mathrm{t}} + \sigma \cdot \tilde{z} \cdot \sqrt{\Delta \mathrm{t}}) \tag{2.8}$$

Where the length of each interval is $\Delta$t, $\tilde{z}$ is the random value from the standard normal distribution N (0; 1) for each random scenario which is in accomplished in Excel by means of *Random Number Generation*.

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[1] https://en.wikipedia.org/wiki/Geometric_Brownian_motion

The mean value of the model is formulated by

$$E(S_T) = S_0 \cdot \exp(\mu \cdot \sqrt{\Delta t} \cdot n) \tag{2.9}$$

The last step is graphical illustration and comparison of historical and estimated values of our random risks. This mean value will be shown as a line with scenarios in the graph of Random variables evolution. In our thesis, the model will be applied in Jet Fuel market price and Passengers carried prediction.

### 2.3.2 Vašíček model

The second method is Vašíček model. The estimation in the discrete version of the (mean-version) Vašíček model describe the evolution of the random variable. This method is applied for the simulation technique of the random evolution of target risk which the mean-reverting processes are typical, in this case, the significant character of the fluctuation of this risk is their reversion to the long-run average. It is a type of one-factor short rate model and describe the movements as one source of market risk, it can be also seen as a stochastic investment model.

The previous method we supposed that all input data are known. By contrast, in Vašíček model, we concentrate on all statistical estimation of input parameters of financial model. We will estimate the parameters of the Vašíček model by least square method including the verification of the statistical significance of particular parameters and the entire model by the *t*-test and the *F*-test respectively.

Firstly we will use the historical data method to estimate of particular parameters for our target value. Based on the historical data, we apply logarithmic function to generate “Input X range”,

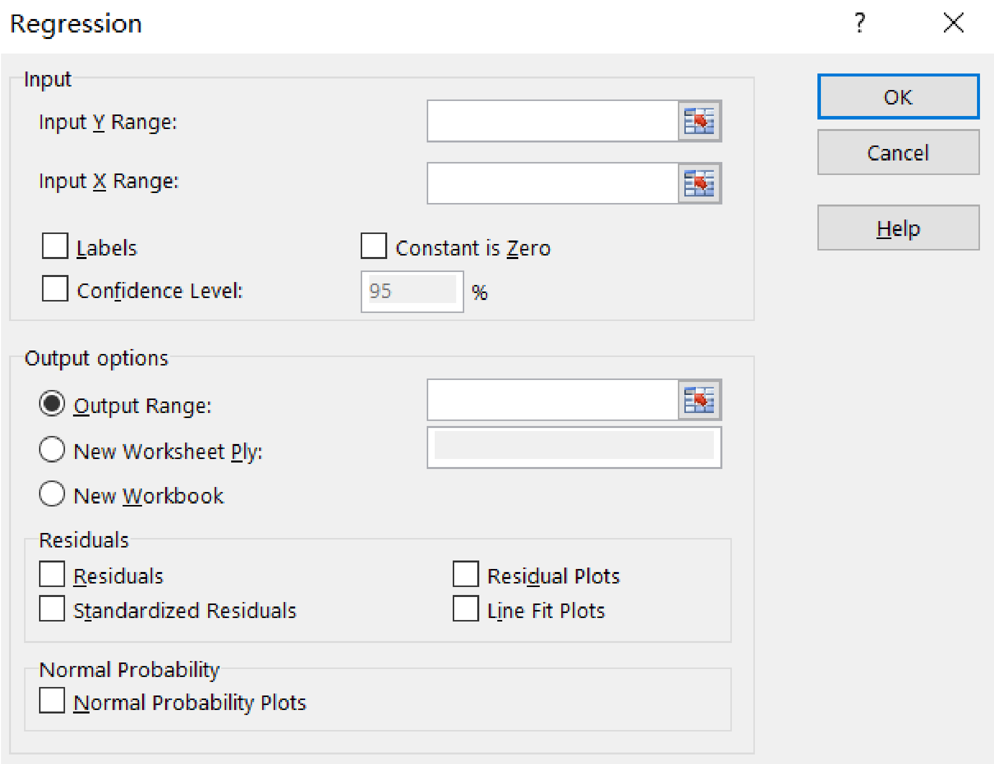
$$X = \ln S_t \tag{2.10}$$

Where $S_t$ is the random value of correlated market risk, then we apply logarithmic function again to obtain “Input Y range”,

$$Y = \ln \frac{S_t}{S_{t-1}} \tag{2.11}$$

Next we will use least square method by using the function “Regression” in Excel to get parameters, the procedure is: Data → Data Analysis → Regression, where we insert computed “Input X range” and “Input Y range” into the specific cell of the window in Figure 2.3.

*Figure 2.3 Regression by Least Square Method*




As we already mentioned in the beginning that we will test the significance of the parameters in the model, the cell named "Confidence Level" in Figure 2.3 normally is 95%, but we can adjust it into 90% based on the result of P-value to make sure that our model is statistically significant.

From *Regression* function we can get "Summary Output" of our value: the value of two estimated parameters $\hat{\alpha}$ and $\hat{\beta}$ from cell "Coefficient of intercept" and Coefficient of "X Variable 1" which can be detailed in practical part. The independent parameter $\hat{\alpha}$ and $\hat{\beta}$ is computed from Least Square Method. According to the "Summary Output", we will check the P-value with our confidence level first to make sure the significance of the model then we can go on with the next step by using the parameter of this output.

Within the statistically significant model, we can calculate of the initial parameters of the Vašíček model which on the basis of parameters estimated for the linear model by using the value of $\hat{\alpha}$ and $\hat{\beta}$. The parameter Δt is time interval based on basis data of this function.

$$\alpha = -\frac{\hat{\beta}}{\Delta t} \tag{2.12}$$

$$b = \frac{\hat{\alpha}/\alpha}{\Delta t} \tag{2.13}$$

The random estimate of the model (*r*) is divided into two parts, the trend ($\tilde{r}$) and the residual deviation (ε), the formula is as follows

$$\Delta r = \Delta\tilde{r} + \varepsilon \tag{2.14}$$

In formula (2.14) *r* is the value of "Input X range", where $\Delta r$ is the random increment of result "Input Y range". The residual deviation (ε) can be calculated by

$$\varepsilon_t = \Delta r - \Delta\tilde{r} = \Delta r - (\hat{\alpha}+\hat{\beta} \cdot r_{t-1}) \tag{2.15}$$

With the result of $\varepsilon_t$, the standard deviation $\hat{\sigma}$ can be calculated by

$$\hat{\sigma} = \sqrt[2]{\frac{\sum_{t=1}^{T} \varepsilon_t}{N}}) \tag{2.16}$$

In formula (2.16) where N is the number of observations which can be found in "Summary Output", then we can obtain the value of standard deviation of Vašíček model by

$$\sigma = \frac{\hat{\sigma}}{\Delta t} \tag{2.17}$$

The long-term equilibrium value $b_{exp}$ of this model can be calculated in Excel by

$$b_{exp} = \mathrm{EXP}(b) \tag{2.18}$$

The discrete type of the Geometric Vašíček model estimated by Least Square Method (LSM) for one time period can be formulated by

$$r_t = r_{t-1} \cdot \exp(\alpha \cdot (b - \frac{\varepsilon_t}{r_{t-1}}) \cdot \Delta t + \sigma \cdot \sqrt{\Delta t} \cdot \tilde{z}) \tag{2.19}$$

All calculated parameters of two models can be shown in one table as followed table 2.1.

*Table 2.1 Parameters in Linear model and Vašíček model*

| Liner model | Vašíček model |
|---|---|
| Parameter | Parameter |
| $\hat{\alpha}$ | α |
| $\hat{\beta}$ | b |
| $\hat{\sigma}$ | σ |
| Initial $r_0$ | $b_{exp}$ |

Having make sure the value of $\hat{\alpha}$ is positive, and the model is statistically significant, then the model can be widely applied for the target market risk. In our thesis, the model will be applied in Exchange rate USD/GBP prediction.

### 2.3.3 Weighted average method

The third method is the weighted average method, we can also call it average growth rate method. It focus on the growth rate of adjacent two data, among our estimated time period, all of the growth rate will be summed up and make an average to obtain the estimated growth rate for our predicted random variables.

Firstly we estimate the average rate by

$$\mathrm{i} = \frac{\sum_{T=2}^{T} \frac{S_T - S_{T-1}}{S_{T-1}}}{T} \tag{2.20}$$

In equation (2.20) where i is the average growth rate (weight), $S_T$ is the historical value in specific period, $T$ is the total time interval. Next we will calculate the predicted value by applying this growth rate.

$$S_t = S_{t-1} \cdot (1 + i)^n \tag{2.21}$$

The parameter $S_t$ is the predicted value, $n$ is the time period that we want to predict. This method is only applied in the data set which the fluctuation is quite flat, in our thesis this method will be used for calculating the predicted value in Cargo revenue, other revenue and part of other components in total cost.

### 2.3.4 Simple average method

The fourth method is the simple average method, this method is applied for the value which fluctuate intensely that we can't easily use weighted average to get precisely value, like extremely changing percentage. The procedure of calculating the value can be shown by

$$S_t = \frac{\sum_{T=1}^{T} S_T}{N} \tag{2.22}$$

As we already mentioned that $S_T$ is historical value, among such historical time, we summed all historical date up and make the average of them to get our predicted value $S_t$. In our thesis, this simple average method will be applied in the calculation of partly other total cost components. Due to the fact that we only find the historical report from 2013 to 2017 in the internet, the value in 2018 is not available, and our predicted year is 2019, so here we only use value from 2013 to 2017 to estimate.

## 2.4 Estimation of net operating profit

In this part we will analyse the procedure of estimating net operating profit step by step, from total operating revenue to total operating costs.

### 2.4.1 Estimated total operating revenue

According to the four methods in chapter 2.3, we can obtain all predicted components of revenues and costs. The basic formula for total operating revenue is by

$$\mathrm{R}_{\mathrm{t}}^{i} = \mathrm{R}_{t,PC}^{i} + R_{t,Cargo} + R_{t,Other} \tag{2.23}$$

In formula (2.23) where $\mathrm{R}_{\mathrm{t}}^{i}$ is Total operating revenue in given time "t" with random change "i", $\mathrm{R}_{t,PC}^{i}$ is total Passengers revenue, $R_{t,Cargo}$ and $R_{t,Other}$ are Cargo revenue and Other revenue in given time "t" which means they are relatively constant. We consider Passengers carried revenue as variable revenue, cargo revenue and other revenue as fixed revenue.

Within the random variable Passengers carried in our thesis, the Passengers revenue can be calculated with our assumption of weight and average air ticket price from the report by

$$\mathrm{R}_{t,PC}^{i} = \mathrm{Q}_{PC} \cdot W_{USD} \cdot P_{USD}/ER_{USD/GBP} + Q \cdot W_{GBP} \cdot P_{GBP} \tag{2.24}$$

In formula (2.24) "$\mathrm{Q}_{PC}$" is quantity of total Passengers carried, "W" is assumed weight and "P" is the average price per one air ticket.

The predicted equation of our target year 2019 is by

$$\mathrm{R}_{2019,\mathrm{total}}^{i} = \mathrm{R}_{2019,PC}^{i} + R_{2019,Cargo} + R_{2019,Other} \tag{2.25}$$

### 2.4.2 Estimated total operating costs

Next we will estimate the total operating costs of our thesis. The basic equation of predicted total operating cost in 2019 is as follows,

$$\mathrm{TOC}_{2019}^{i} = \sum_{1}^{4} \mathrm{FC}_{Q}^{i} + OOC_{2019} \tag{2.26}$$

In equation (2.26) where $\mathrm{TOC}_{2019}^{i}$ is total operating cost in given time with different scenarios, $\mathrm{FC}_{Q}^{i}$ is quarterly Fuel cost, $\mathrm{FC}_{2019}$ is total Fuel cost, $OOC_{2019}$ is other operating cost in 2019.

In total operating costs prediction, as we already mentioned that Jet Fuel price is the market risk for our company, here the Fuel cost is most uncertainty component which is considered as variable costs, the others are fixed cost, so we need to estimate it separately.

$$\mathrm{FC}_{t}^{i} = Q_{t,F} \cdot AFP_{t}^{i} \cdot ER_{t}^{i} \tag{2.27}$$

In equation (2.27), where $\mathrm{FC}_{t}^{i}$ is Fuel cost in given time "t" with different changing "i", $Q_{t,F}$ is the quantity of Fuel cost, and $AFP_{t}^{i}$ is average Fuel price, $ER_{t}^{i}$ is exchange rate USD/GBP.

### 2.4.3 Estimated net operating profit

The final step in this chapter is to estimate net operating profit in 2019 according to our aim this thesis, the basic formula between total revenues, total costs and net operating profit is

$$\mathrm{NOP}_{t} = \mathrm{R}_{t} - TOC_{t} \tag{2.28}$$

In equation (2.28) $\mathrm{NOP}_{t}$ is Net Operating profit in given time "t". Within all of the components from predicted revenue and costs, the estimation of net operating profit can be obtained with 1000 scenarios from our simulation evolution.

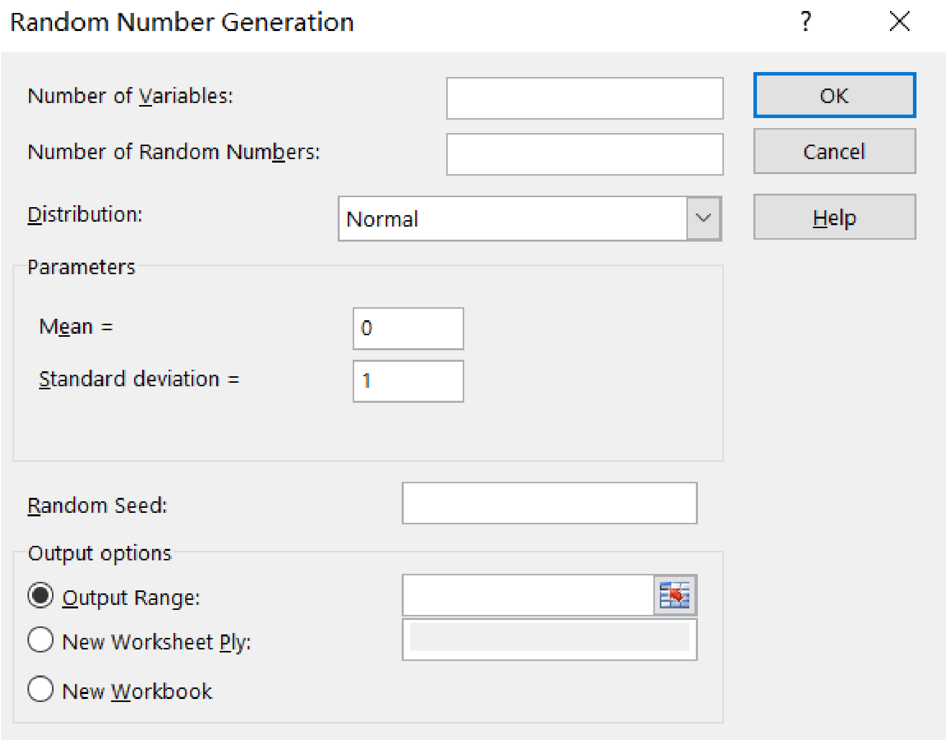
## 2.5 Frequency distribution analysis

In this part we will introduce the frequency function application to estimate our probability distribution of each sector.

### 2.5.1 Probability distribution

Having decided the model, the next step is to generate random values $\tilde{z}$ from the standard normal distribution for each random scenarios. This procedure is by means of the *Random Number Generation* in Excel by: *Tools → Data Analysis → Random Number*. Here we insert 1000 scenarios for our simulation, under normal distribution with 0 mean and 1 in standard deviation, which can be shown in Figure 2.4.

*Figure 2.4 Random number generation*




There are different types of probability distribution, in our thesis we choose standard normal distribution for our random values to obtain frequency distribution and statistical output.

Based on the model and all predicted value, we will apply FREQUNECY function in Excel to figure out the frequency of each computed equidistant interval by

$$\text{Equidistant interval (E)} = \frac{X_{max} - X_{min}}{10} \tag{2.29}$$

Max is the maximum and Min is minimum value from our 1000 simulated value. The example table of FREQUENCY can be shown in table 2.2.

*Table 2.2 Frequency and probability distribution*

| | Predicted interval | Frequency | Probability |
|---|---|---|---|
| MIN | $X_{min}$ | ⋯ | ⋯ |
| | $X_{min} + E$ | ⋯ | ⋯ |
| | $X_{min} + 2 \cdot E$ | ⋯ | ⋯ |
| | ⋯ | ⋯ | ⋯ |
| MAX | $X_{max}$ | ⋯ | ⋯ |
| SUM | | 1000 | 100% |
| Equidistant interval | E | | |

In table 2.2, the example of frequency output tells the calculating procedure of interval value, based on this distribution we can figure out the value range of target prediction to make analyzation. This function will be applied in predicted Passengers carried revenue, total operating revenue, Fuel cost, total operating costs and net operating profit.

### 2.5.2 Graph and Statistical table

Due to the result of frequency table, we graphically perform them with *Three-dimensional figure* to analyse our predicted value from fully angle. Furthermore we will arrange the table of characteristic in predicted value, the form of which can be shown in table 2.3

*Table 2.3 Statistical output of predicted value*

| Item | Mean | ST.DEV | MIN | MAX | 2.5% Percentile | 97.5% Percentile |
|---|---|---|---|---|---|---|

Table 2.3 shows the item in statistical output table, it performs the characteristic of our predicted value.

### 2.5.3 Sensitivity analysis

At last we will make the sensitivity analysis to figure out the level of influence from specific random risk on our net operating profit, in this thesis we will change the drift α on Passengers revenue and Jet Fuel market price. Changing the drift α to can obtain another 1000 scenarios value in predicted net operating profit. Then we will apply FREQUENCY function, make a graph, and collect the statistical output of new net operating profit to compare with the original value.

# 3. Characterization of British Airways Company

In this chapter we will present the basic condition of British Airways Corporation in four sections: Overview of British Airways, history description of British Airways, Financial conditions of British Airways and SWOT analysis of British Airways

## 3.1 Overview of British Airways

British Airways Plc ('British Airways', 'BA', 'the airline' or 'the Group') is the UK's largest international scheduled airline and one of the world's leading global premium airlines. Founded on March 31, 1924, the company is headquartered in London Heathrow Airport, with a global flight network covering more than 150 destinations in 75 countries. The Figure 3.1 shows the logo of British Airways Corporation

*Figure 3.1 Logo of British Airways Corporation*

(*Source: https://cs.wikipedia.org/wiki/British_Airways*)

The British aircraft tail logo was made up of the British flag which can be shown on the right side of Figure 3.1, but at the end of 1997, British Airways replaced some of the fuselage logos. The logo of the tail was changed from the British rice flag to the national pattern of each country. The tail patterns are different (depending on the route destination), but in 2001 they began to use the artistic variant of the British flag.

The Group's principal place of business is London with significant presence at Heathrow, Gatwick and London City airports. British Airways' exclusive London Heathrow Airport

Terminal 5 was commissioned on March 27, 2008, which is its main hub, and London Gatwick Airport is a secondary site. As part of IAG (International Airlines Group) and together with joint business, codeshare and franchise partners, it operates one of the most extensive international scheduled airline networks. IAG is the parent company of British Airways and Iberia, featuring one of the largest cargo carrier networks in the world. British Airways is a founding member of the "Oneworld" alliance, whose member airlines serve more than 1,000 destinations in over 150 countries. The logo of "Oneworld" alliance is in following Figure 3.2.

*Figure 3.2 Logo of Oneworld" alliance*

(*Source: https://cs.wikipedia.org/wiki/Oneworld*)

The formation of alliances by airlines is mainly to reduce costs, concentrate on advantages, complement each other, and of course service quality is also one of the key factors for membership.

During the year the Group operated more than 290 aircraft, carrying customers to over 200 destinations in more than 80 countries. British Airways is renowned for its excellent tradition of providing quality service and is renowned throughout the world. In December 2018, the World Brand Lab[2] released the "Top 500 of the World's most Influential Brands" list, and British Airways ranked 459.

## 3.2 History description of British Airways

In this chapter we will introduce the history of British Airways from the beginning to present time. The data is according to the history from British Airways Official website.

[2] http://www.worldbrandlab.com/world/2018/brand/brand.html

The set-up of British Airways[3] (BA) can search back to the birth of civil aviation after World War I. It's already been 99 years since the world's first schedule air service on 25 August 1919. The development of civil aviation is out of people's expectation. Each decade is full of new opportunities and challenges, we will look back on different eras to see how British Airways achieve the airline it is today.

That first flight took off from Hounslow Heath on 25 August 1919, since Aircraft Transport and Travel Limited (AT&T) which is a forerunner company of today’s British Airways, launched the world’s first daily international scheduled air service between London and Paris.

In 1924 the predecessor of British Airways—Imperial Airways was created as the government’s “chosen instrument of air travel” by the amalgamation of The Instone Air Line Ltd., Handley Page Air Transport Ltd.

In 1935 there is a merger among four private airlines which composed the independent British Airways Limited.

In April 1940 the new state airline British Overseas Airways Corporation (BOAC) was formed and started wartime services. In 1946, British European Airways (BEA) and British South American Airways (BSAA) were created to conduct commercial business on Europe and South America respectively since the London Airport was opened.

In 1965 the world’s first fully automatic landing carrying commercial passengers is made by a BEA Trident at Heathrow.

In 1974 the merger of BOAC and BEA made up the new British Airways. In 1976 British Airways introduced the world's fastest passenger airliner Concorde at the time. It is one of the two airlines in the world that have Concorde supersonic airliners.

In 1987 under the leadership of Chairman Lord King, British Airways completed its privatisation. In 1988 British Airways was merged with Gatwick-based British Caledonian Airways.

In 1999, British Airways formed an "Oneworld" aviation alliance with American Airlines, Canadian Airlines (now acquired by Air Canada), Cathay Pacific Airways and Qantas Airways.

In 2006, British Airways was selected by Skytrax as the world's best airline of the year.

[3] Source: https://www.britishairways.com/en-de/information/about-ba/history-and-heritage

In 2008, the fifth passenger terminal of London Heathrow International Airport, owned by British Airways, was officially opened.

From 2010 to present day, Newly-created International Airlines Group (IAG) is formed and takes over British Airways and Iberia. This transaction produced the third largest airline in Europe.

## 3.3 Financial conditions of British Airways

In this chapter we will perform the financial condition of British Airways Corporation. The reports we applied in this thesis are from 2013 to 2017. The following table 3.1 will present the overview[4] of British Airways according to report 2017 of BA.

*Table 3.1 Overview Continuing operations of British Airways*

| | 2017 | 2016 |
|---|---|---|
| Total revenue | £12,226 million , up 6.4% | £11,443 million |
| Operating profit before exceptional items | £1,744 million, up 15.5% | £1,473 million |
| Passengers | 45.2 million, up 2.0% | 44.3 million |
| Punctuality | 80%, up 3 points | 77% |

*(Source: British Airways Plc Annual Report and Accounts Year ended 31 December 2017)*

For the year despite operating in a challenging environment characterised by industrial action, extreme weather events, terror attacks and volatile fuel prices, the company still make an increasing in total revenue in 2017 from table 3.1. The strategic of competition from low cost carriers continues to grow.

Economic factors such as a weaker pound sterling have a positive effect on the Group's reported revenues where air ticket becomes cheaper for foreign passengers. The effect of fuel hedging activity led to an increase in the reported results. Then we will perform the table 3.2 for financial review of *British Airways.*

[4] Source: http://www.iairgroup.com/phoenix.zhtml?c=240949&p=irol-reportsannual

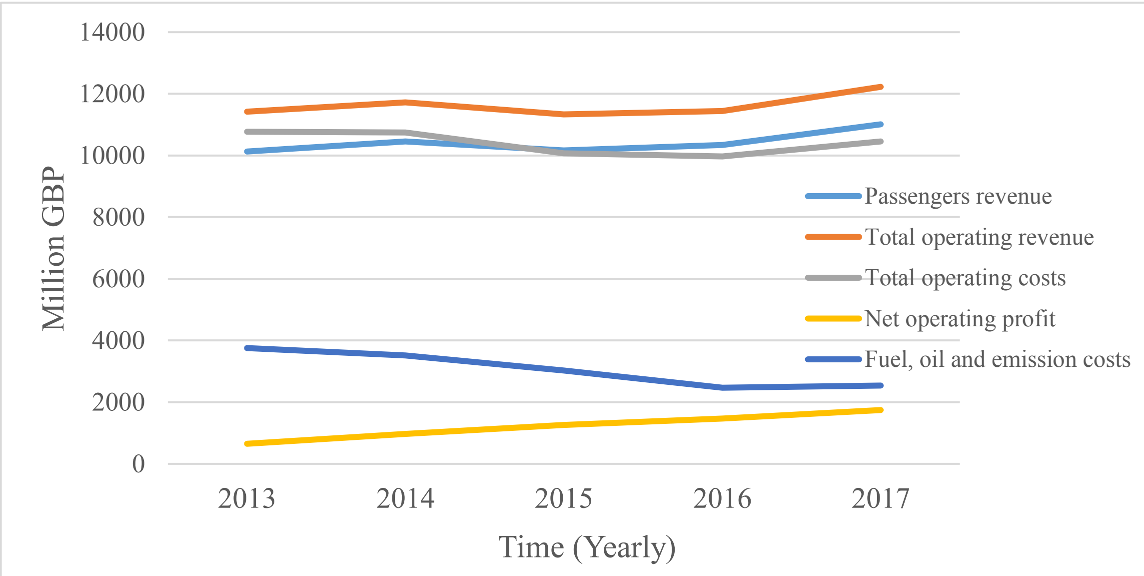
*Table 3.2 Financial review of a summary of the BA's financial results*

| Million GBP | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Passengers carried | 39.9 | 42.0 | 43.3 | 44.3 | 45.2 |
| Passengers revenue | 10129 | 10452 | 10164 | 10340 | 11011 |
| Total operating revenue | 11421 | 11719 | 11333 | 11443 | 12226 |
| Total operating costs | 10770 | 10744 | 10069 | 9970 | 10452 |
| Net operating profit | 651 | 975 | 1264 | 1473 | 1744 |
| Fuel, oil and emission cost | 3755 | 3515 | 3031 | 2469 | 2537 |

*(Source: British Airways Plc Annual Report and Accounts from 2013-2017)*

In table 3.2 we can see that the net operating profit increased a lot among these years, the other items didn't have quite big changes with steady fluctuation. The following Figure 3.3 is the horizontal analysis of the item in table 3.2.

*Figure 3.3 Horizontal analysis of financial results of British Airways*




*(Source: British Airways Plc Annual Report and Accounts from 2013-2017)*

In Figure 3.3 we can find that Passengers revenue and total operating revenue has quite similar trend, which due to the biggest proportion of Passengers revenue in total revenue and the increasing quantity of Passengers carried. The line total cost is always under line total revenue, we can see it from net operating revenue, which is kept increasing all the time. Fuel cost is one of the biggest proportion among total costs, the decreasing of Fuel costs made total costs increased slowly.

The increase in revenue is driven by rising premium yields and by all major currencies strengthening against sterling and strong business sector performance across some long-haul routes. However, the increase of Fuel cost is mainly attributed to adverse foreign exchange caused by the weakening of sterling against the US dollar due to continued uncertainty following, because the company's oil price is settled in US dollars against the British pound.

So the British Airways is exposed to currency risk on revenue, purchases and borrowings in foreign currencies along with currency devaluation of cash held in currencies other than the airline's local currency (sterling). Fuel price Volatility in the price of oil and petroleum products can have a material impact on the Group's operating results. Based on the reality, we can find that Passengers carried, Fuel price and Exchange rate USD/GBP are the most uncertainty factor on the company's revenue and costs, finally makes influence on the net operating profit.

## 3.4 SWOT analysis of British Airways

The last part is the SWOT analysis of British Airways, it contains: strengths, weaknesses, opportunities, and threats which related to business competition. The Figure 3.4 below is the overview of SOWT analysis of BA, in addition we will add more details in following text.

*Figure 3.4 SWOT analysis of British Airways*

| ***Strengths*** | ***Weaknesses*** |
|---|---|
| 1. Economies of scale due to its large size<br>2. Strong brand image<br>3. Market leadership in the UK<br>4. High level of service digitalization and effective integration of IT and internet | 1. Overdependence on the UK market<br>2. Low return on invested capital (ROIC)<br>3. Constrained capacity of Heathrow airport<br>4. Lack of experience of the new CEO Alex Cruz in leading the premium segment airline |
| ***Opportunities*** | ***Threats*** |
| 1. Formation of strategic cooperation with other businesses in airline and catering industries<br>2. International market expansion<br>3. Benefiting from synergy via Closer integration between IAG's operating airlines<br>4. Improving relations with unions | 1. Further intensification of competition<br>2. Terrorist attacks<br>3. Service distuptions due to employee strikes<br>4. Escalation of the conflict with the UK government |

*(Source: Research Methodology by John Dudovskiy)*

### 3.4.1 Strengths of British Airways

British Airways has 90 years of experience in the industry, it is the UK's largest international airline and one of the world's leading global premium airlines backed by UK Government.

Brand has significant commercial value which is established as a brand with high levels of consumer recognition and trust. Under the connection with its parent company International Airline Group (IAG) which is the world's 3rd largest in terms of revenue, British Airways has become the largest UK airline in financial size and stability by flying to more than 400 destinations around the world.

The extensive scope of its operations not only in Passengers carried, but also cargo services makes it gain revenues from the economies of scale to a great extent. This part of revenue is reinvesting in promoting the airlines' competitive advantage from investing in new advanced fleets and improving a greater personalization of service provision.

BA has its own engineering branch to maintain its aircraft fleet, it includes line maintenance at over 70 airports around the world, which saved a large amount of costs for the company.

British Airlines is a tech – savvy company. It combined IT and internet to develop an online ordering system by various processes and a high level of digitalization in response to the growing importance of the internet in the travel and tourism industry to increase the competitive advantage.

### 3.4.2 Weaknesses of British Airways

The British Airlines is over dependence in domestic market. More than 50% of their revenues come from local market. Basically, it's not bad because it can save extra costs and decrease the risk by under different exchange rate, however considering the background of globalized economy it can't take risk of relying on single market.

In addition British Airways has a large unionised workforce. They always hold collective bargaining on a regular basis, during the bargaining process of making a breakdown, it may disrupt operations and adversely affect business performance.

Although British Airways has good business around the world through subsidiaries but still they has under-penetrated in the globalized market. The developing markets has high potential, stable economy high speed of developing, and the quality of people's living is getting better based on the rise in income, especially India, China etc., British Airways is lack of the shares in such markets.

### 3.4.3 Opportunities of British Airways

The growing speed of developing economies is faster than ever before, such markets start improving investment in the travel infrastructure, the rising of income expanded from the middle class lead to the large demand of travelling, and foreign tourism which create significant opportunities of international business for the airline company to develop new airline route. The consumer group increased means the market demand increased as well.

Based on Government interventions by & large affecting the operations of airline companies, the regulation of the aviation industry becomes more and more strict, it limits the development of small airlines, they can't afford high costs, long transition cycles and struggle of global economy. Many of the competitors are forced to exit the market, most of them are small players.

### 3.4.4 Threats of British Airways

The price of the air ticket plays an essential role in consumer's flying decision making. Under the globalized economy, although the income of consumers increased among such years, however the unstable economy and consumer psychology, they preferred choosing the ticket with lower price or discount which makes the competition more intense among companies. Some small companies whose cost structures are lower than British Airways targeting budget, relies on the measures to absorb passengers by providing cheap ticket to survive, which made a negative effect on the British Airways, it provides high quality of services must make fare discounting to maintain passenger traffic to respond to competitors.

The escalation of the conflict between British Airways and the UK government influence the revenues of the company. The airline industry is highly regulated by Government

Regulations such as routes they fly, the business partners they cooperate with, the airport slots they use, the fares they set, the infrastructure costs they pay or safety are governed by tight regulations.

With the development of technology, people's travel methods become diversified, improvement in infrastructure in developed and developing world there are lots of alternatives modes of transportation like Bullet trains, Underground metros emerge with high speed and lower price possess a serious threat to airlines industry.

# 4. Application of the CorporateMetrics Methodology and Comments on Results

In this chapter we will apply CorporateMetrics Methodology to quantify the market risk in British Airways Corporation. The aim of this chapter is to estimate the probability distribution of net operating profit based on simulation in predicted year 2019 by following steps. We assume the net operating profit is affected by 3 random variables: Jet Fuel market price, Passengers carried and Exchange rate. Then we will make simulation for each of these external risks to predict total revenue, total cost and net profit. At the end we will perform sensitivity analysis.

## 4.1 Prediction of random variables

In order to predict these three variables, we need to analyse their historical trend to decide which model that we will apply, after that we will make prediction for each of them based on simulation evolution.

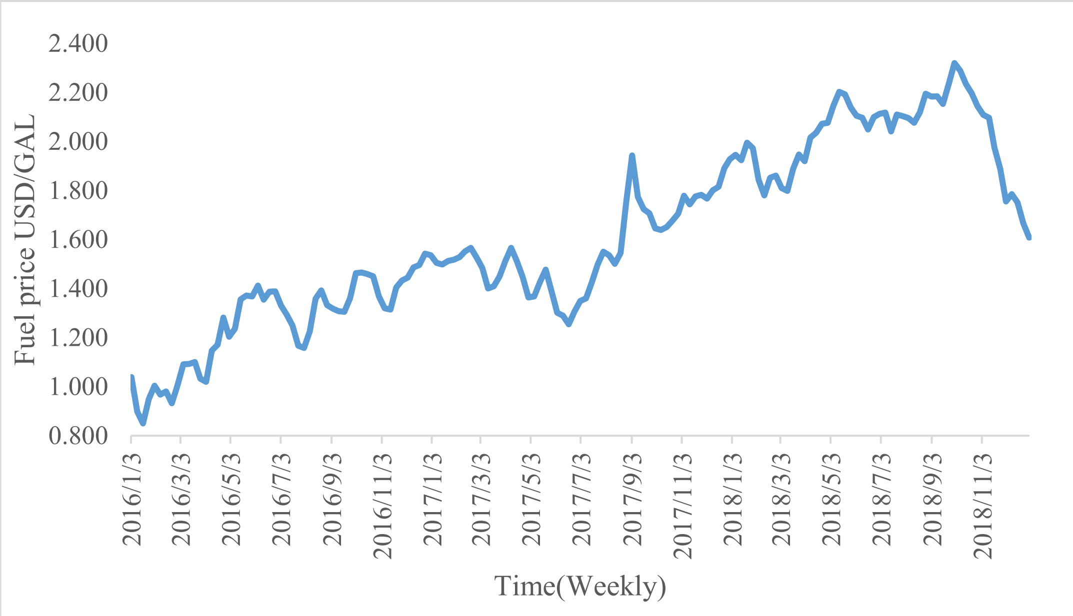
### 4.1.1 Prediction of Jet Fuel market price

The first external risk is Jet Fuel market price. In order to predict Jet Fuel market price, we collect weekly historical data of it between January 2016 and December 2018. Then we will select proper model depends on the trend of our historical data to make the prediction of Jet Fuel market price for year 2019.

**a) Historical trend of Jet Fuel market price**

The time interval of Jet Fuel market price is from 3$^{rd}$ January 2016 to 30$^{th}$ December 2018, we choose weekly data as our sample, the sample size is composed of 157 numbers of weekly data. The Figure 4.1 shows the trend of our data collected from internet.

*Figure 4.1 Weekly Jet Fuel market price from 3rd January 2016 to 30th December 2018*




In Figure 4.1 we can find that the Jet Fuel market price has clear tendency, it kept increasing most time of this period though it looks quite fluctuate, all of them are between 0.8 USD/GAL and 2.4 USD/GAL, where GAL is Gallon. Based on the clear trend, we decide to use Geometric Brownian motion as our main tool to modelling and making a prediction. The time period we want to predict for Jet Fuel market price is year 2019 which included 52 weeks.

Due to the formula (2.4), (2.5), (2.6), (2.7), the parameter of in this model are mean value (α), standard deviation (σ), interval (Δt) can be calculated in equation set (4.1), initial Jet Fuel market price $JFP_0$ and number of steps (N). The historical Jet Fuel market price is in weekly as well as our prediction time interval, so the parameter Δt is equal to 1. Here we choose the last week of Jet Fuel market price in 2018 as our initial price $JFP_0$. The estimated value of Jet Fuel market price and other parameters can be shown in equation set (4.1) and table 4.1 below:

$\mu = \text{AVERAGE}(\text{LN}(P_2/P_{2-1}): \text{LN}(P_{157}/P_{157-1})) = 0.28\%$ per week

$\sigma^2 = \text{VAR.P}(\text{LN}(P_2/P_{2-1}): \text{LN}(P_{157}/P_{157-1})) = 0.17\%$ per week

$\sigma = \text{STDEV.P}(\text{LN}(P_2/P_{2-1}): \text{LN}(P_{157}/P_{157-1})) = 4.14\%$ per week

$\alpha = 0.0028 - \frac{0.00171}{2} = 0.19\%$ per week

$$\text{JFP}^{i}_{t+1} = \text{JFP}_t \cdot \exp(0.0019 \cdot 1 + 0.0414 \cdot \tilde{z} \cdot \sqrt{1}) \quad \text{per week} \tag{4.1}$$

*Table 4.1 Parameters used for simulation of Jet Fuel market price evolution*

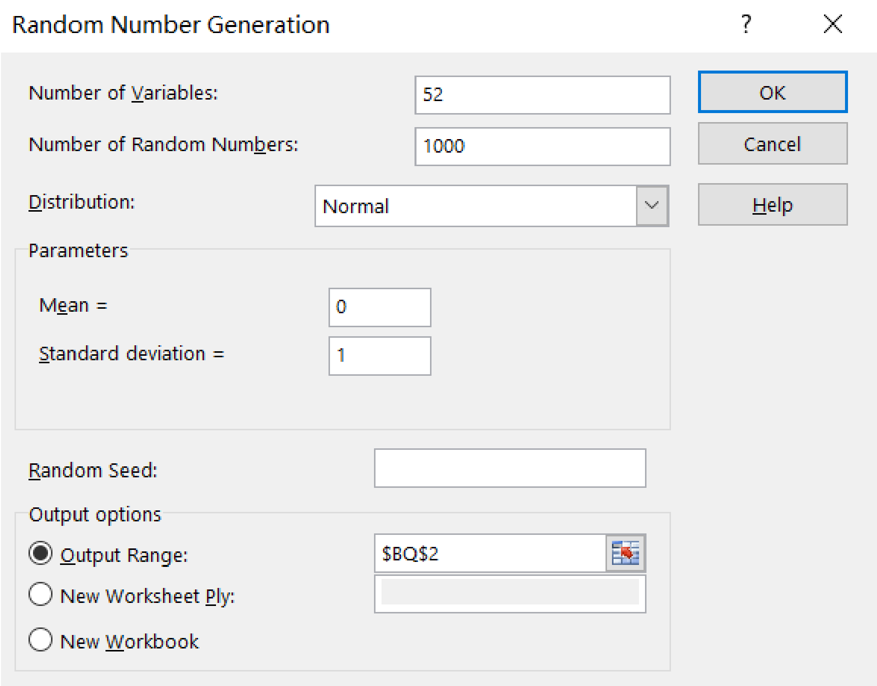
| Parameter | α(%) | σ(%) | Δt | $JFP_0$ | N |
|---|---|---|---|---|---|
| Value | 0.19% | 4.14% | 1.0 | 1.608 | 157 |

The result of the parameters in Jet Fuel market price can be shown in equation set (4.1) and table 4.1, where $JFP^{i}_{t+1}$ is Jet Fuel price always changed in given time "t", it is the basic function for Jet Fuel price simulation, p.w represent per week.

**b) Simulation of Jet Fuel market price evolution**

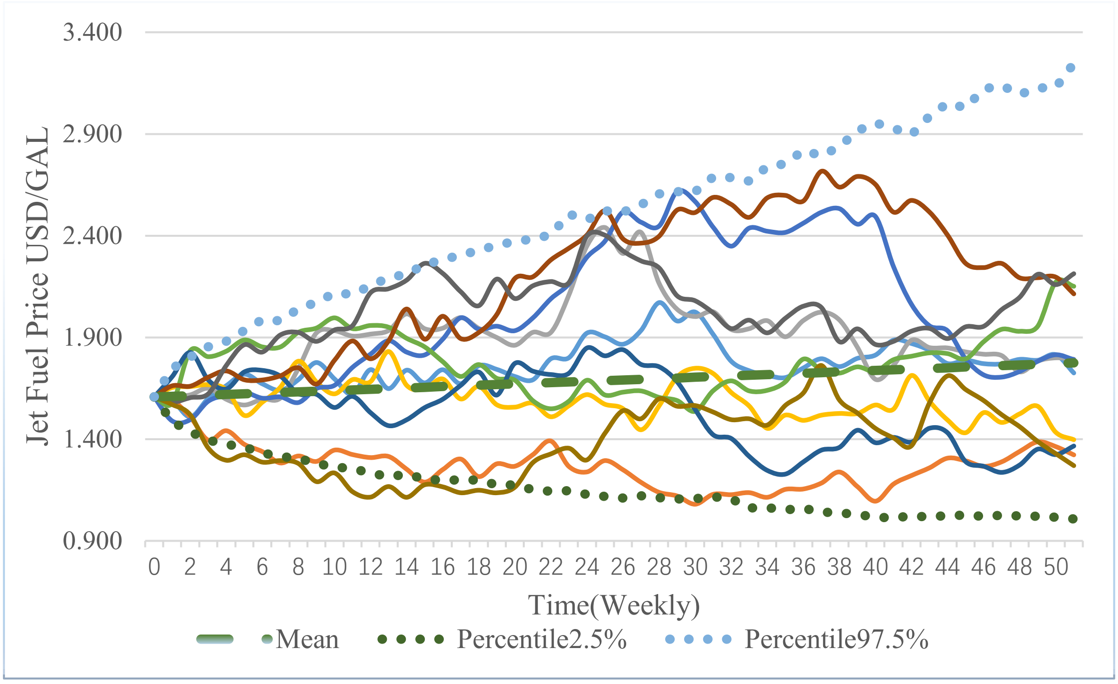
The first step of simulation is to generate random value $\tilde{z}$ from the standard normal distribution for each random scenario. The procedure can be done in Excel by means of Random Number Generation. Here we need 1000 scenarios for 52 prediction sample. The specific process is as follows: *Tools* → *Data Analysis* → *Random Number Generation* which can be shown in Figure 4.2.

*Figure 4.2 Specifying the Random Number Generation for standard normal distribution*




The next step is to put the parameter we already computed in Table 4.1 and random numbers into new column by using formula (2.8) to get final result. The graphically results is shown by Figure 4.3.

*Figure 4.3 10 scenarios of Random Jet Fuel market price evolution*




Due to the huge size of our sample, we only choose first 10 samples to set up our graph, including one expected value line named "Mean" (Gradient line) which is calculated by formula (2.9) and two percentile line in 2.5% and 97.5% (Round join type), which means that we cut the upper and lower number, the percentile represent the rest of 95% value are distributed among it. In Figure 4.3, we predict year 2019 for every week among this year, there are 52 weeks in year 2019, "0" in horizontal line means the first week in 2019, the number in vertical line represent Jet Fuel unit is USD per gallon. We can't tell the exact trend of these lines from the scenarios, also due to the trend coefficient α is 0.19% which is quite small. But the line of mean value raised slowly.

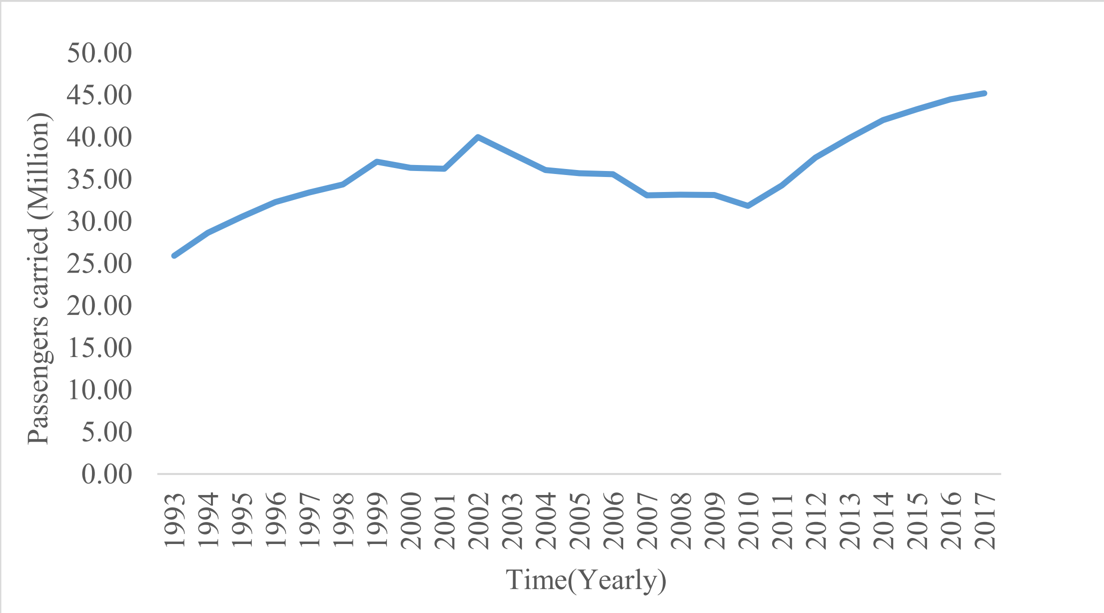
**4.1.2 Prediction of Passengers carried**

The second external risk is Passengers carried, as we already introduced in chapter three, the company we chose is British Airways, passenger revenue has high proportion in total revenues. We find yearly historical data of Passenger carried in 1993 to 2017, next we will select model based on the trend of its historical data to make prediction of Passengers carried in year 2019.

**a) Historical trend of Passengers carried**

The time interval of Passengers carried is from 1993 to 2017, there are 25 yearly data composed our historical sample size. The Figure 4.4 shows the trend of historical data of Passengers carried from the report.

*Figure 4.4 Yearly Passengers carried from 1993 to 2017*




In Figure 4.4 the Passengers carried increased most of this period, except year 2002 to year 2010 which decreased around eight million of passengers. In year 2017, it reached its highest amount of Passengers carried 45.2 million. Due to the main trend, we decide to use Geometric Brownian motion as our main tool to modelling and making a prediction for Passengers carried.

Based on formula (2.4), (2.5), (2.6), (2.7), the parameter of these method are mean value ($\alpha$), standard deviation ($\sigma$), interval ($\Delta t$) can be computed in equation (4.2), initial Passengers carried $PC_0$ and number of steps (N). Here we choose the Passengers carried in 2017 as initial $PC_0$. Our aim is to make simulation for year 2018 and 2019 in quarterly. However, our historical data is yearly, so we divide the value in 2017 by 4 into quarterly, therefore the parameter $\Delta t$ is equal to 1. Between 1993 to year 2017, we have 25 historical samples. The parameter $\mu$ is continuous value. The estimated value of Passengers carried and other parameters can be shown in equation set (4.2) and table 4.2 below:

$\mu$ = AVERAGE (LN ($P_2/P_{2-1}$): LN ($P_{25}/P_{25-1}$)) = 2.2% p.a.

$\sigma^2$ = VAR.P (LN ($P_2/P_{2-1}$): LN ($P_{25}/P_{25-1}$)) = 0.24% p.a.

$\sigma$ = STDEV.P (LN ($P_2/P_{2-1}$): LN ($P_{25}/P_{25-1}$)) = 4.9% p.a.

$$\alpha = 0.02319 - \frac{0.00238}{2} = 2.20\% \qquad \text{p.a.}$$

$$PC_{t+1}^{i} = PC_t \cdot \exp\left(0.022 \cdot 1 + 0.049 \cdot \tilde{z} \cdot \sqrt{1}\right) \quad \text{per week} \tag{4.2}$$

*Table 4.2 Parameters used for simulation of Passengers carried evolution*

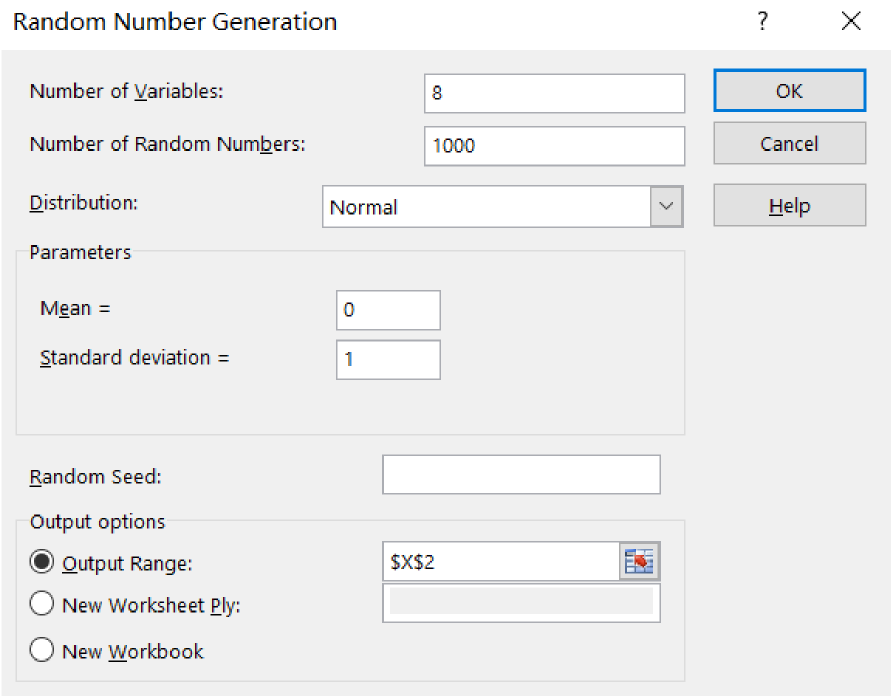
| Parameter | α(%) | σ(%) | Δt | $PC_0$ | N |
|---|---|---|---|---|---|
| Value | 2.2% | 4.9% | 1.0 | 11.3 | 25 |

The result of the calculation and function procedure can be shown in equation set (4.2) and table 4.2, where $PC_{t+1}^{i}$ is Passengers carried always changed in given time "t", it is the basic function for Passengers carried simulation, p.a. means per annual.

**b) Simulation of Passengers carried evolution**

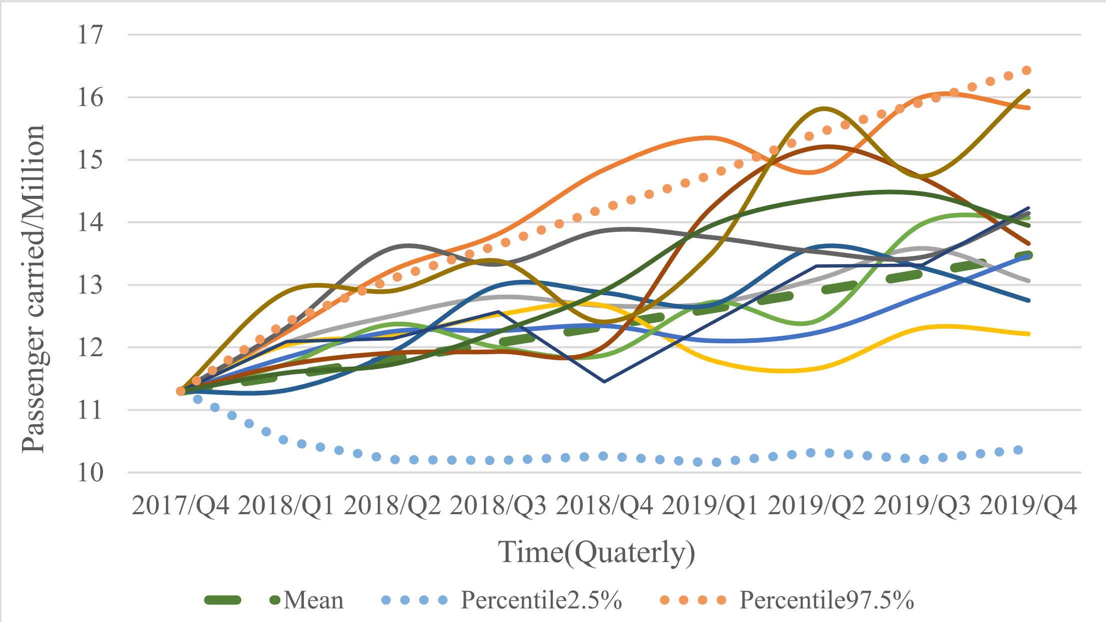
The first step of simulation is to generate random value $\tilde{z}$ from the standard normal distribution for each random scenario. The procedure can be done in Excel by means of Random Number Generation. Here we need 1000 scenarios for 8 prediction samples (4 quarter in 2018 and 2019). The specific process is as follows: *Tools* → *Data Analysis* → *Random Number Generation* which can be shown in Figure 4.5.

*Figure 4.5 Specifying the Random Number Generation for standard normal distribution*




The next step is to put the parameter we already computed in Table 4.2 and random numbers into new column by using formula (2.8) to get final result. The graphically results is shown by Figure 4.6.

*Figure 4.6 10 scenarios of Random Passengers carried evolution*




In Figure 4.6, we only select 10 scenarios among 1000 sample size to set up our graph, including one expected value line named "Mean" (Gradient line) which is calculated by formula (2.9) and two percentile line in 2.5% and 97.5% (Round join type). According to the graph, we can see that the scenarios have typical tendency of increasing among our prediction period, as well as the mean value which increased quite steady. As for percentile, the scenarios are not so closely related from this figure, it might due to the small sample size. The point gathered in 2017/Q4 is our initial Passengers carried 11.3 million, the rest are prediction period.

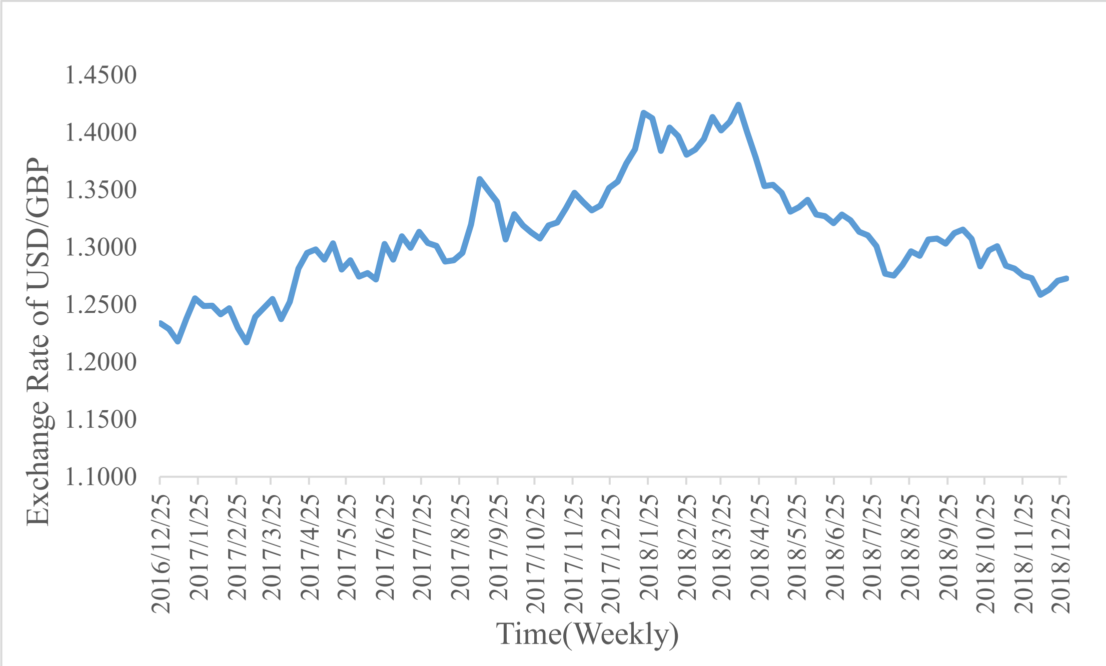
### 4.1.3 Prediction of USD/GBP exchange rate

The third variable we need to concern is Exchange rate. Due to the fact that Jet Fuel is a necessity for Airways Company, the exchange rate as an intermediary plays a significant role among transaction which changed every day, and most of our transactions are connected with United States Dollars (USD) and Great Britain Pound (GBP). Here we select weekly data of Exchange rate USD/GBP in 2016-2018 as our sample, after that we will decide the model based on historical figure and make prediction of Market exchange rate in 2019.

**a) Estimating historical trend of Market exchange rate**

In order to select proper model for Exchange rate(ER) USD/GBP, we collect weekly data from 25th December 2016 to 30th December 2018, there are 106 historical samples. The Figure 4.7 shows the historical trend of Exchange rate USD/GBP.

*Figure 4.7 Weekly exchange rate of USD/GBP from 25th December 2016 to 30th December 2018*

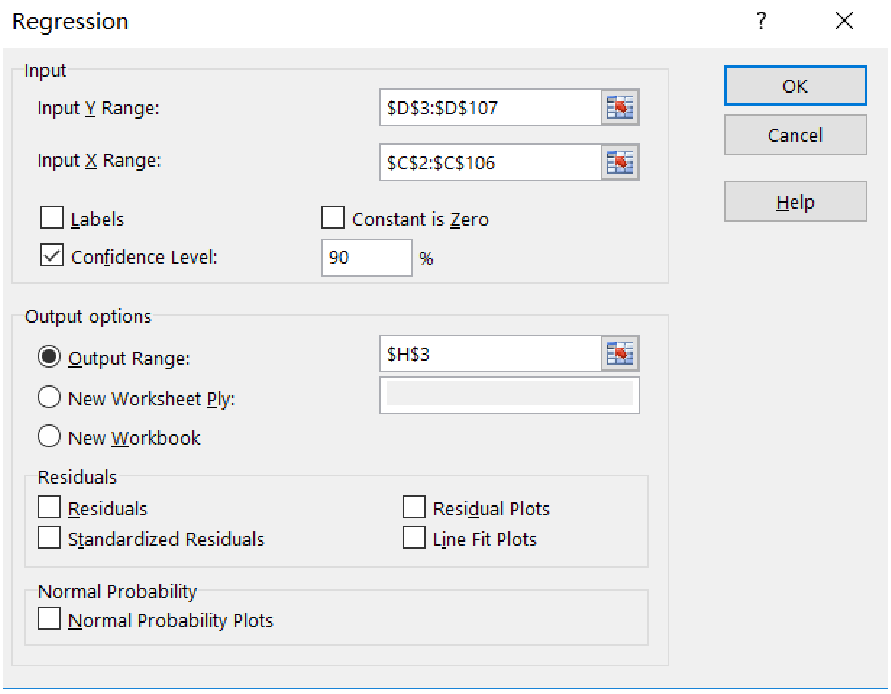



In Figure 4.7 we can see the historical line ER USD/GBP doesn't have typical trend but looks like around a long-term equilibrium line, it increased until April 2018 then decreased until December 2018, so we decide to use Vašíček model to make a prediction of Exchange rate USD/GBP in year 2019.

**b) Estimation and regression analysis of Vašíček model**

In order to get the parameters, firstly we use the function "Regression" in Excel, the specific procedure is: Data → Data Analysis → Regression, the final step is substituting data which can be shown in Figure 4.8.

*Figure 4.8 Substituting data to set up the regression model*




In Figure 4.8, we adjust initial historical Exchange rate value by formula (2.10) as "Input X Range", then we apply formula (2.11) to get new data as "Input Y range". Here we use 90% confidence level to test due to the reality when using 95% we got negative intercept of Coefficients which is nonsense to our model, in the meanwhile to make sure that our P-value is statistically significant. Hence we got the result of regression function in Table 4.3.

*Table 4.3 Regression Statistics output*

SUMMARY OUTPUT

| Regression Statistics | |
|---|---|
| Multiple R | 0.181963236 |
| R Square | 0.033110619 |
| Adjusted R Square | 0.023723344 |
| Standard Error | 0.040014026 |
| Observations | 105 |

ANOVA

| | df | SS | MS | F | Significance F |
|---|---|---|---|---|---|
| Regression | 1 | 0.005647448 | 0.005647 | 3.527180918 | 0.063198804 |
| Residual | 103 | 0.164915597 | 0.001601 | | |
| Total | 104 | 0.170563045 | | | |

| | Coefficients | Standard Error | t Stat | P-value | Lower 95% | Upper 95% | Lower 90.0% | Upper 90.0% |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.05466165 | 0.028671797 | 1.906461 | 0.059377503 | -0.002202097 | 0.111525398 | 0.00707271 | 0.102250591 |
| X Variable 1 | -0.197232967 | 0.105018459 | -1.87808 | 0.063198804 | -0.405512311 | 0.011046377 | -0.371540744 | -0.022925191 |

According to Table 4.3 we obtain two parameters $\hat{\alpha}$ and $\hat{\beta}$ from "Coefficient of intercept" and Coefficient of "X Variable 1" which belong to linear model. The historical Market exchange rate is in weekly as well as our prediction time interval, so the parameter $\Delta t$ is equal to 1. Here we assume our time interval $\Delta t$ is 1. Based on formula (2.12), (2.13), (2.16) and (2.17), with the value of $\hat{\alpha}$ and $\hat{\beta}$ can easily get the result of $\alpha$, $\beta$, $\hat{\sigma}$ and σ, the result of all calculated values and procedure can be shown in equation (4.3) and table 4.4.

$$\alpha = -\frac{-0.19723296}{8} = 0.19723296 \quad \text{per week}$$

$$b = \frac{0.05466165/0.19723296}{1} = 0.27714256 \quad \text{per week}$$

$$\hat{\sigma} = \text{SQRT (SUMSQ } (\varepsilon_1 : \varepsilon_{105})/105) = 0.03963111 \quad \text{per week}$$

$$\sigma = \frac{0.03963}{1} = 0.03963111 \quad \text{per week} \tag{4.3}$$

*Table 4.4 Calculated parameters for Linear model and Vašíček model*

| Liner model | | | Vašíček model | |
|---|---|---|---|---|
| Parameter | value | P-value | parameter | Value |
| $\hat{\alpha}$ | 0.05466165 | 0.0594 | α | 0.19723296 |
| $\hat{\beta}$ | -0.19723296 | 0.0632 | b | 0.27714256 |
| $\hat{\sigma}$ | 0.03963111 | | σ | 0.03963111 |
| Initial $\mathrm{ER}_0$ | 1.2728 | | EXP(b) | 1.31935445 |

In table 4.4 ε is residual deviation which can be computed by formula (2.15). EXP means make the value return back to normal value, the long-term equilibrium value $\mathrm{b}_{exp}$ can be computed by formula (2.18). We can see that P-value of the linear model are statistically significant at the 10% probability level:

P-value: 0.0594 < 10%

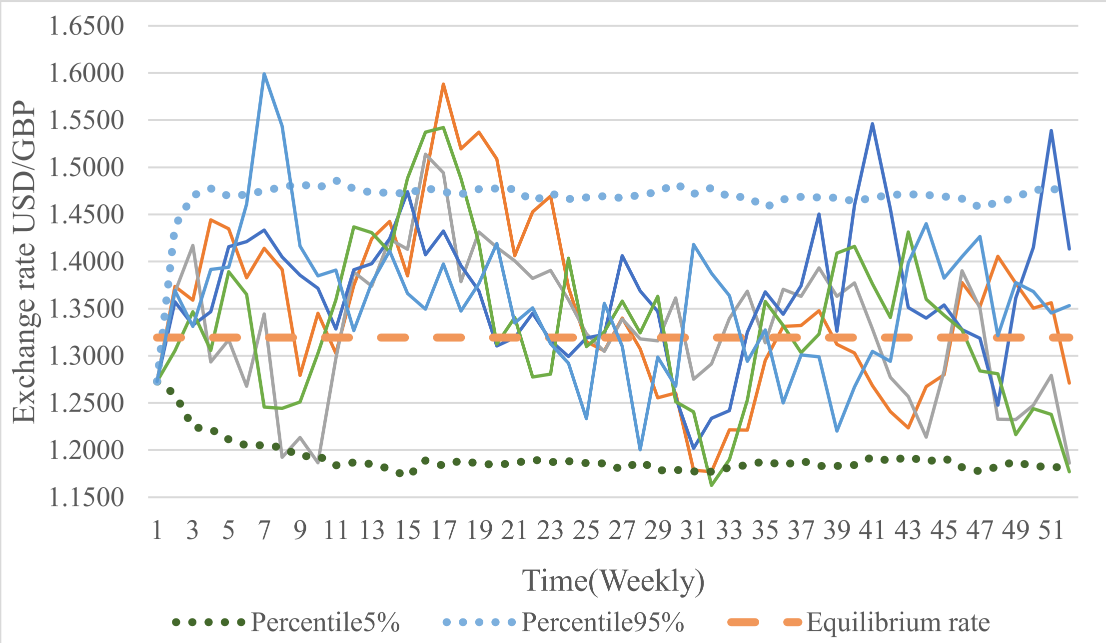
P-value: 0.0632 < 10%

The initial $\mathrm{ER}_0$ is USD/GBP exchange rate in 30th December 2018, and use function "EXP" to return parameter b into normal unit. The discrete type of the Geometric Vašíček model estimated by Least Square Method (LSM) can be formulated by formula (2.19) as follows:

$$ER_{t+1}^{i} = \mathrm{ER}_t \cdot \exp(0.19723 \cdot (0.27714 - LN(\mathrm{ER}_t)) \cdot 1 + 0.03963 \cdot \sqrt{1} \cdot \tilde{z}) \tag{4.4}$$

The equation (4.4) is the basic function for ER simulation, we insert 1000 scenarios of 52 weeks in year 2019, the next step is to generate random value $\tilde{z}$ from the standard normal distribution for each random scenario and combine the LSM method that we mentioned above with initial Market exchange rate 1.2728 USD/GBP, where $ER_{t+1}^{i}$ is Exchange rate USD/GBP with different scenarios "i" in given time "t". The final step of this model is graphical illustration which will be shown in Figure 4.9.

*Figure 4.9 5 scenarios of Random Market exchange rate evolution*




In Figure 4.9, in order to have a clear look with our complicated trend, we only insert 5 scenarios into the graph including one long-run equilibrium named "Equilibrium rate" (Gradient line) line with the value of $b_{exp}$ and two percentile line in 2.5% and 97.5% (Round join type).We can see that all of our scenarios are surrounding the long-term equilibrium line and move not so far from two percentile lines.

## 4.2 Prediction of total operating revenue

Having finished prediction of three variables, next we need to predict total operating revenue. Our total revenue is composed of Traffic revenue and other revenue. Traffic revenue is composed by Passenger revenue and Cargo revenue. Their relationship can be shown as follow equations:

$$R_t^i = R_{t,PC}^i + R_{t,Cargo} + R_{t,Other} \quad (4.5)$$

Equation (4.5) shows the component of our total operating revenues.

### 4.2.1 Prediction of Passenger revenue

Passenger revenue as an uncertain variable, we need to estimate it separately from other revenues. As we already made the prediction of Passengers carried in 2019, our first step is to measure Passenger revenue in 2019. We assume our Passengers revenues are composed of two components: one is in GBP and the other is in USD. The basic data is in table 4.5.

*Table 4.5 Basic data for specifying Passenger revenue*

| Item | X | Y |
|---|---|---|
| Avg.Price/Ticket | 300 USD/Ticket | 200 GBP/Ticket |
| Weight | 30% | 70% |
| Passenger revenue(2017) | 11011 | (£ million) |

Based on the reality that the selected company is a British company, most of the transactions were paid in GBP, only small part of USD. According to the report, we find the average price of air ticket in USD is 300 and GBP is 200. In table 4.5 we assume 30% weight for USD and 70% weight for GBP, which is formed based on the simulation and significant of prediction. And our Exchange rate is in USD/GBP, all of these relationship can be shown in equation set below:

$$\mathrm{R}_{t,PC}^{i} = \mathrm{Q}_{PC} \cdot W_{USD} \cdot P_{USD}/ER_{USD/GBP} + Q \cdot W_{GBP} \cdot P_{GBP}$$

$$\mathrm{R}_{t,PC}^{i} = \mathrm{Q}_{PC} \cdot 0.3 \cdot 300/ER_{USD/GBP} + Q \cdot 0.7 \cdot 200 \quad (4.6)$$

Total operating revenue is predicted quarterly which had same interval as Passengers carried did. So we calculate each quarter based on the equation set (4.6) with our predicted quarterly Passengers carried and Market exchange rate.

In order to determine the probability distribution of quarterly Passenger revenue, we apply the Excel function FREQUENCY (Data_array; Bin_array). Data_array means 1000 scenarios of Passenger revenue in each quarter, Bin_array states boundaries for the intervals to which the data are assigned. In order to set intervals, we apply functions MIN (Data_array) and MAX (Data_array) to state the minimal and maximal generated quarterly Passenger revenue. Next, we will calculate equidistant interval with minimal and maximum value to get boundaries with 10 intervals. Finally we apply the function FREQUENCY (Data_array; Bin_array) to get frequency and probability of Passenger revenue in each quarter which are shown in table 4.6 to table 4.9, the unit is in Million GBP. The equidistant interval for each quarter is calculated by formula (2.29) as follows:

$$\text{Equidistant interval Q1} = \frac{3746.0689\text{-}1834.1146}{10} = 191.1954 \qquad \text{Million/GBP}$$

$$\text{Equidistant interval Q2} = \frac{3932.2970\text{-}1828.6872}{10} = 210.3610$$

$$\text{Equidistant interval Q3} = \frac{4057.9885\text{-}1717.4043}{10} = 234.0584$$

$$\text{Equidistant interval Q4} = \frac{4276.1895\text{-}1831.4186}{10} = 244.4771$$

*Table 4.6 Frequency and probability distribution of Passenger revenue in 1st quarter of 2019*

| | $R_{PC}$/Q1 | Frequency | Probability |
|---|---|---|---|
| MIN | 1834.1146 | 1 | 0.1% |
| | 2025.3100 | 6 | 0.6% |
| | 2216.5055 | 62 | 6.2% |
| | 2407.7009 | 152 | 15.2% |
| | 2598.8963 | 249 | 24.9% |
| | 2790.0918 | 237 | 23.7% |
| | 2981.2872 | 174 | 17.4% |
| | 3172.4826 | 73 | 7.3% |
| | 3363.6781 | 36 | 3.6% |
| | 3554.8735 | 7 | 0.7% |
| MAX | 3746.0689 | 3 | 0.3% |
| | SUM | 1000 | 100% |
| Equidistant interval | | 191.1954 | |

*Table 4.7 Frequency and probability distribution of Passenger revenue in 2nd quarter of 2019*

| | $R_{PC}$/Q2 | Frequency | Probability |
|---|---|---|---|
| MIN | 1828.6872 | 1 | 0.1% |
| | 2039.0482 | 4 | 0.4% |
| | 2249.4092 | 62 | 6.2% |
| | 2459.7701 | 185 | 18.5% |
| | 2670.1311 | 237 | 23.7% |
| | 2880.4921 | 238 | 23.8% |
| | 3090.8531 | 134 | 13.4% |
| | 3301.2140 | 95 | 9.5% |
| | 3511.5750 | 32 | 3.2% |
| | 3721.9360 | 7 | 0.7% |
| MAX | 3932.2970 | 5 | 0.5% |
| | SUM | 1000 | 100% |
| Equidistant interval | | 210.3610 | |

*Table 4.8 Frequency and probability distribution of Passenger revenue in 3rd quarter of 2019*

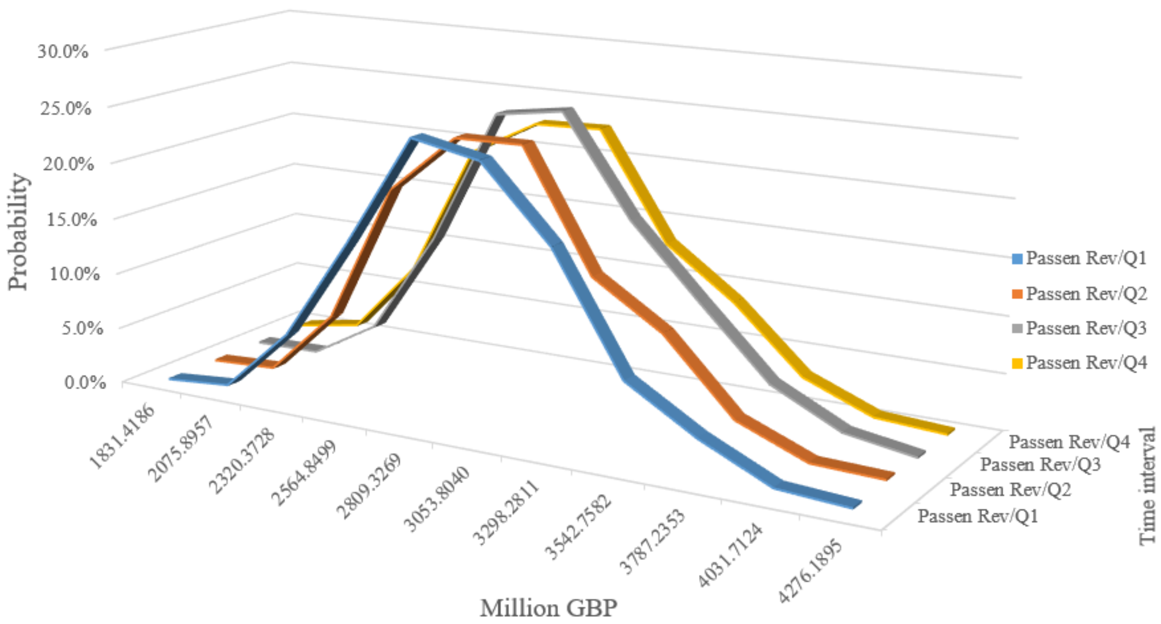
| | $R_{PC}$/Q3 | Frequency | Probability |
|---|---|---|---|
| MIN | 1717.4043 | 1 | 0.1% |
| | 1951.4627 | 2 | 0.2% |
| | 2185.5211 | 36 | 3.6% |
| | 2419.5796 | 127 | 12.7% |
| | 2653.6380 | 246 | 24.6% |
| | 2887.6964 | 255 | 25.5% |
| | 3121.7548 | 168 | 16.8% |
| | 3355.8133 | 105 | 10.5% |
| | 3589.8717 | 44 | 4.4% |
| | 3823.9301 | 13 | 1.3% |
| MAX | 4057.9885 | 3 | 0.3% |
| | SUM | 1000 | 100% |
| Equidistant interval | | 234.0584 | |

*Table 4.9 Frequency and probability distribution of Passenger revenue in 4th quarter of 2019*

| | $R_{PC}$/Q4 | Frequency | Probability |
|---|---|---|---|
| MIN | 1831.4186 | 1 | 0.1% |
| | 2075.8957 | 11 | 1.1% |
| | 2320.3728 | 76 | 7.6% |
| | 2564.8499 | 194 | 19.4% |
| | 2809.3269 | 226 | 22.6% |
| | 3053.8040 | 228 | 22.8% |
| | 3298.2811 | 133 | 13.3% |
| | 3542.7582 | 89 | 8.9% |
| | 3787.2353 | 32 | 3.2% |
| | 4031.7124 | 7 | 0.7% |
| MAX | 4276.1895 | 3 | 0.3% |
| | SUM | 1000 | 100% |
| Equidistant interval | | 244.4771 | |

From table 4.6 to table 4.9 we got intuitive frequency distribution of each quarter, the Passenger revenue is sorted from minimal to maximum from the table with different frequency and relative proportion where $R_{PC}$/Q is Passenger revenue in different quarter. The most frequent interval of each quarter in Passenger revenue among 1000 scenarios are 2407.70 to 2598.90, 2670.13 to 2880.49, 2653.64 to 2887.69 and 2809.33 to 3053.80 million GBP. The revenue between minimum and maximum is calculated by plus equidistant interval in turn. Following Figure 4.10 shows probability distribution of predicted Passengers revenue.

*Figure 4.10 Probability distribution of predicted Passengers revenue in each quarter*



In Figure 4.10 the Passengers revenue is positive. Most of the proportion distributed quite centralized between intervals from 2564.8 to 3053.8 million GBP. In addition, all of the lines distributed most in the left side of the figure, it can tell that passenger revenue distributed in lower to middle value range with higher proportion than the proportion in high value range. It looks like crossing the "Watershed". No matter the exact value of the probability, these four lines have quite similar tendency and distribution. The characteristic of Passenger revenue in each quarter is shown in following table 4.10.

*Table 4.10 Statistic output of predicted Passenger revenue in 2019 (Million GBP)*

| | Passenger quarterly revenue of 2019 | | | |
|---|---|---|---|---|
| | $R_{PC}$/Q1 | $R_{PC}$/Q2 | $R_{PC}$/Q3 | $R_{PC}$/Q4 |
| Mean | 2636.196 | 2701.841 | 2762.129 | 2823.032 |
| ST.DEV | 292.382 | 330.749 | 358.094 | 392.520 |
| MIN | 1834.115 | 1828.687 | 1717.404 | 1831.419 |
| MAX | 3746.069 | 3932.297 | 4057.989 | 4276.189 |
| 2.5% Percentile | 2111.440 | 2127.728 | 2145.040 | 2160.654 |
| 97.5% Percentile | 3255.692 | 3385.505 | 3524.052 | 3671.649 |

In table 4.10 we can find more details to measure quarterly Passenger revenue. In the mean row, the revenue is gradually increasing from 1st to 4th quarter, as well as other items, it is consistent with the prediction of Passengers carried evolution of 2019. The fourth quarter has highest maximum passenger revenue among the prediction year. Compare the mean and standard deviation, the higher the value of mean, the higher value of standard deviation. It conforms to the reality when Passengers carried grown up, Passengers revenue also increased.

### 4.2.2 Estimation of Total operating revenue

In order to estimate the total operating revenue in 2019, we need to know the composition of other components. Firstly we look back to the historical income statement of revenue in table 4.11 and equation (4.7) of Total operating revenue.

$$\mathrm{R}^{i}_{2019,\mathrm{total}} = \mathrm{R}^{i}_{2019,PC} + R_{2019,Cargo} + R_{2019,Other} \tag{4.7}$$

*Table 4.11 Historical Total revenue composition in Income statement*

| Million GBP | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Passenger revenue | 10129 | 10452 | 10164 | 10340 | 11011 |
| Cargo revenue | 689 | 598 | 547 | 589 | 683 |
| **Traffic revenue** | 10818 | 11050 | 10711 | 10929 | 11694 |
| Other revenue | 603 | 669 | 622 | 514 | 532 |
| **Total revenue** | 11421 | 11719 | 11333 | 11443 | 12226 |

In table 4.11 we can see the component of total revenue, as we already mentioned passenger revenue is uncertain (Passenger carried is uncertain) and the other components are relatively steady, so we apply weighted average method by formula (2.20) and (2.21) to give specific weight for each component to predict their value in 2019. According to the equation (4.7) where $\mathrm{R}^{i}_{2019,\mathrm{total}}$ is total revenue of 2019, the others are the components of revenue in 2019. The following table 4.12 shows the predicted value of Cargo and Other revenue in 2019.

*Table 4.12 Predicted Revenue components in 2019*

| Item | 2019(Revenue) |
|---|---|
| Cargo revenue | 763 |
| Other revenue | 489 |

We need to make prediction of revenue component in 2019, however the data in 2018 is not available from the Internet, so we predict the value in both 2018 and 2019 but only keep the value of 2019. Table 4.12 tells the exact results of predicted value of Cargo and Other revenue in 2019. The next step is to sum all components up to obtain total prediction revenue then apply FREQUENCY function. The equidistant interval and frequency probability of Total revenue in 2019 are in following equation and table 4.13:

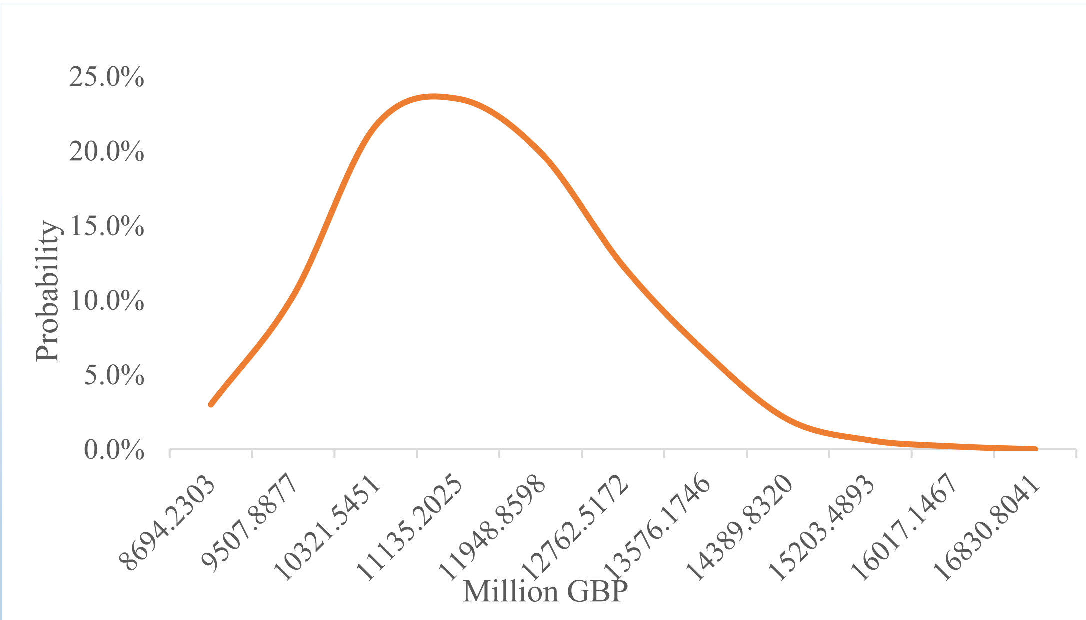
$$\text{Equidistant interval of total revenue} = \frac{16830.8041\text{-}8694.2303}{10} = 813.6574 \text{ Million/GBP}$$

*Table 4.13 Frequency and probability distribution of Total operating revenue for 2019 (Million GBP)*

| | Total revenue | Frequency | Probability |
|---|---|---|---|
| MIN | 8694.2303 | 30 | 3.0% |
| | 9507.8877 | 103 | 10.3% |
| | 10321.5451 | 217 | 21.7% |
| | 11135.2025 | 235 | 23.5% |
| | 11948.8598 | 199 | 19.9% |
| | 12762.5172 | 123 | 12.3% |
| | 13576.1746 | 65 | 6.5% |
| | 14389.8320 | 20 | 2.0% |
| | 15203.4893 | 6 | 0.6% |
| | 16017.1467 | 2 | 0.2% |
| MAX | 16830.8041 | 30 | 3.0% |
| | SUM | 1000 | 100% |
| | Equidistant interval | 813.6574 | |

Table 4.13 shows the frequency and probability of total revenue, the most frequent interval is 10321.5 to 11135.2 million GBP which is quite close to the total revenue in 2017. The final step is graphically showing the probability distribution which is shown in following Figure 4.11.

*Figure 4.11 Probability distribution of predicted Total operating revenue for 2019*




In Figure 4.11 the top of line Total revenue probability is placed on the left side of this figure, it increased from the beginning until interval between 10321.5451 to 11135.2025 (million GBP), after exceeding this top, the line kept decreasing.

## 4.3 Prediction of Total operating cost

Operating cost plays an essential role between total revenue and net profit, the Fuel cost is influenced by Jet Fuel market price and exchange rate. According to our report, the operating cost has several components which need to be predicted separately. So we estimate the Jet Fuel cost firstly.

### 4.3.1 Prediction of Jet Fuel cost

Firstly, there are some basic relationship that we need to mention in table 4.14 and equation (4.8).

$$\mathrm{FC}_t^i = Q_{t,F} \cdot AFP_t^i \cdot ER_t^i$$

$$2537 = 2092 \cdot 1.566/1.291 \tag{4.8}$$

*Table 4.14 Basic information for Jet Fuel cost prediction*

| | | |
|---|---|---|
| Average Jet Fuel price (2017) | 1.566 | USD/GAL |
| Average Exchange rate (2017) | 1.291 | USD/GBP |
| Fuel cost (2017) | 2537 | Million/GBP |
| Consumption (2017) | 2092 | Million GAL |

In table 4.14, according to report 2017, we compute the consumption of Jet Fuel with Fuel cost, average Jet Fuel price and average Exchange rate (2017). As we know that Fuel price is the most volatile factor in the equation, Fuel consumption is relatively stable, so we assume the consumption is fixed. We will use the value 2092 to predict our Fuel cost in 2019.

We already predicted the Jet Fuel market price with weekly scenarios, here we need to adjust them into quarterly price to be applied for average quarterly Fuel costs prediction, as well as the ER is being adjusted into quarterly, the consumption of one year will be divided by 4 in the calculation process.

The first step is to transform the predicted 1000 weekly scenarios into quarterly data, as well as the predicted Exchange rate USD/GBP. Further we will create quarterly Fuel cost and sort it from lowest to highest. In order to determine the probability distribution of quarterly Passenger revenue, we apply the Excel function FREQUENCY (Data_array; Bin_array) again.

Data_array means 1000 scenarios of Fuel cost in each quarter, Bin_array states boundaries for the intervals to which the data are assigned. Finally we got the frequency result which can be shown in table 4.15 to 4.18, the unit is in million GBP. The equidistant interval is calculated as follows:

$$\text{Equidistant interval Q1} = \frac{846.604\text{-}495.495}{10} = 35.1108 \qquad \text{Million/GBP}$$

$$\text{Equidistant interval Q2} = \frac{1216.350\text{-}382.001}{10} = 83.4349$$

$$\text{Equidistant interval Q3} = \frac{1414.039\text{-}310.770}{10} = 110.3269$$

$$\text{Equidistant interval Q4} = \frac{1851.573\text{-}284.367}{10} = 156.7205$$

*Table 4.15 Frequency and probability distribution of Fuel cost in 1st quarter of 2019*

| | FC/Q1 | Frequency | Probability |
|---|---|---|---|
| MIN | 495.495 | 1 | 0.1% |
| | 530.606 | 15 | 1.5% |
| | 565.717 | 61 | 6.1% |
| | 600.828 | 135 | 13.5% |
| | 635.939 | 236 | 23.6% |
| | 671.049 | 249 | 24.9% |
| | 706.160 | 161 | 16.1% |
| | 741.271 | 99 | 9.9% |
| | 776.382 | 27 | 2.7% |
| | 811.493 | 14 | 1.4% |
| MAX | 846.604 | 2 | 0.2% |
| | SUM | 1000 | 100% |
| Equidistant interval | | 35.1108 | |

*Table 4.16 Frequency and probability distribution of Fuel cost in 2nd quarter of 2019*

| | FC/Q2 | Frequency | Probability |
|---|---|---|---|
| MIN | 382.001 | 1 | 0.1% |
| | 465.436 | 18 | 1.8% |
| | 548.871 | 118 | 11.8% |
| | 632.305 | 281 | 28.1% |
| | 715.740 | 284 | 28.4% |
| | 799.175 | 164 | 16.4% |
| | 882.610 | 88 | 8.8% |
| | 966.045 | 32 | 3.2% |
| | 1049.480 | 11 | 1.1% |
| | 1132.915 | 2 | 0.2% |
| MAX | 1216.350 | 1 | 0.1% |
| | SUM | 1000 | 100% |
| Equidistant interval | | 83.4349 | |

*Table 4.17 Frequency and probability distribution of Fuel cost in 3rd quarter of 2019*

| | FC/Q3 | Frequency | Probability |
|---|---|---|---|
| MIN | 310.770 | 1 | 0.1% |
| | 421.097 | 17 | 1.7% |
| | 531.424 | 125 | 12.5% |
| | 641.751 | 277 | 27.7% |
| | 752.078 | 270 | 27.0% |
| | 862.404 | 165 | 16.5% |
| | 972.731 | 92 | 9.2% |
| | 1083.058 | 33 | 3.3% |
| | 1193.385 | 11 | 1.1% |
| | 1303.712 | 6 | 0.6% |
| MAX | 1414.039 | 3 | 0.3% |
| | SUM | 1000 | 100% |
| Equidistant interval | | 110.3269 | |

*Table 4.18 Frequency and probability distribution of Fuel cost in 4th quarter of 2019*

| | FC/Q4 | Frequency | Probability |
|---|---|---|---|
| MIN | 284.367 | 1 | 0.1% |
| | 441.088 | 44 | 4.4% |
| | 597.808 | 248 | 24.8% |
| | 754.529 | 323 | 32.3% |
| | 911.249 | 231 | 23.1% |
| | 1067.970 | 96 | 9.6% |
| | 1224.690 | 34 | 3.4% |
| | 1381.411 | 15 | 1.5% |
| | 1538.131 | 5 | 0.5% |
| | 1694.852 | 1 | 0.1% |
| MAX | 1851.573 | 2 | 0.2% |
| | SUM | 1000 | 100% |
| Equidistant interval | | 156.7205 | |

From table 4.15 to table 4.18 we obtained frequency and probability of predicted Fuel cost from each quarter, the equidistant interval is calculated in the same step as we did on Passenger revenue. The most frequent interval of each quarter in Fuel cost among 1000 scenarios are 635.94 to 671.05, 632.31 to 715.74, 531.42 to 641.75 and 597.81 to 754.52 million GBP. The graphically probability distribution of quarterly Fuel cost in 2019 is in following Figure 4.12.

*Figure 4.12 Probability distribution of predicted Fuel cost in each quarter*

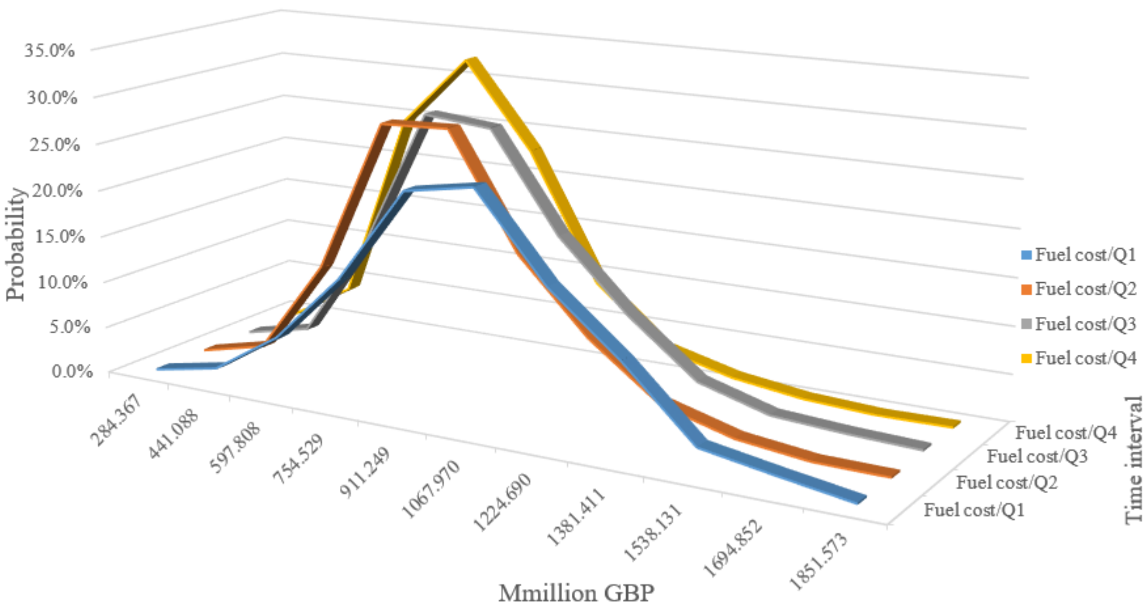



Figure 4.12 shows the Fuel cost of each quarter is positive. Most of the proportion distributed quite centralized between intervals from 754.529 to 1067.970 million GBP.

Moreover most of the probability proportion distributed on the left side of this figure which tells that most fuel cost distributed in lower to medium value range rather than higher range. In addition, these four quarter line has similar distribution and tendency regardless where there top distributed, all of their boundary line between increasing decreasing trend played as "Watershed" which given us more specific prediction result of the Fuel cost. The characteristic of Fuel cost in each quarter is shown in following table 4.19.

*Table 4.19 Statistic output of predicted Fuel cost in 2019 (Million GBP)*

| | Fuel quarterly cost of 2019 | | | |
|---|---|---|---|---|
| | Cost/Q1 | Cost /Q2 | Cost /Q3 | Cost /Q4 |
| Mean | 644.531 | 666.489 | 693.510 | 719.766 |
| ST.DEV | 55.710 | 116.282 | 162.401 | 203.910 |
| MIN | 495.495 | 382.001 | 310.770 | 284.367 |
| MAX | 846.604 | 1216.350 | 1414.039 | 1851.573 |
| 2.5% Percentile | 536.211 | 475.748 | 432.354 | 401.326 |
| 97.5% Percentile | 763.162 | 933.911 | 1049.432 | 1205.661 |

In table 4.19 we use several measurement to analyse the characteristic of each quarter, in the mean row, the value of cost kept increasing from 1st to 4th quarter. The fourth quarter has the lowest minimal value but highest maximum value where the first quarter has highest minimum value but lowest maximum value. Based on our historical data, we find the Jet Fuel price kept increasing from 2016 to 2018 which can explain the increasing of Fuel cost in 2019.

### 4.3.2 Estimation of Total operating cost

Besides the Fuel cost, due to the several component of total operating cost, we find the table 4.20 of total operating cost from the report to and components of total operating cost relationship in equation (4.9)

$$\mathrm{TOC}_{2019}^{i} = \sum_{1}^{4} \mathrm{FC}_{Q}^{i} + OOC_{2019}$$

$$\mathrm{FC}_{2019} = \sum_{1}^{4} \mathrm{FC}_{Q}^{i} \tag{4.9}$$

*Table 4.20 Total operating costs composition in Income statement*

| Million GBP | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Employee costs | 2387 | 2422 | 2466 | 2440 | 2559 |
| Restructuring | 5 | 39 | 27 | 4 | 0 |
| Depreciation, amortisation and impairment | 722 | 831 | 761 | 769 | 751 |
| Aircraft operating lease costs | 85 | 80 | 113 | 159 | 223 |
| **Fuel, oil and emission costs** | **3755** | **3515** | **3031** | **2469** | **2537** |
| Engineering and other aircraft costs | 643 | 613 | 583 | 710 | 763 |
| Landing fees and en route charges | 790 | 787 | 792 | 877 | 930 |
| Handling charges, catering and other operating costs | 1340 | 1381 | 1255 | 1520 | 1649 |
| Selling costs | 439 | 449 | 401 | 415 | 480 |
| Currency differences | 28 | 37 | 46 | 88 | -6 |
| Accommodation, ground equipment and IT costs | 576 | 590 | 594 | 519 | 566 |
| Total expenditure on operations | 10770 | 10744 | 10069 | 9970 | 10452 |

In table 4.20, besides the Fuel cost, the other components of operating costs fluctuates relatively steady or only have quite small proportion which won't have too much impact on our prediction. Table 4.21 below shows the predicted value of costs in 2019.

*Table 4.21 Predicted other operating cost components in 2019*

| Other operating costs(Million GBP) | 2019(Cost) |
|---|---|
| Employee costs | 2670 |
| Restructuring | 15 |
| Depreciation, amortisation and impairment | 767 |
| Aircraft operating lease costs | 372 |
| Engineering and other aircraft costs | |
| Landing fees and en route charges | 891 |
| Handling charges, catering and other operating costs | 1040 |
| Selling costs | 1931 |
| Currency differences | 533 |
| Accommodation, ground equipment and IT costs | 39 |

According to table 4.21 the item have normal percentage changing are applied by weighted average method by formula (2.20) and (2.21), they are Employee costs, Aircraft operating lease costs, Engineering and other aircraft costs, Landing fees and en route charges, Handling charges, catering and other operating costs and Selling costs. The rest costs (except Fuel cost) with extreme changing percentage applied by simple average method by formula (2.22). In this way we can distinguish the proper weight for each item.

The last column of table 4.21 is the result of our predicted value in 2019. Moreover, we sum all the cost components up to create our total predicted operating cost. Theoretically we need to put up the total cost of 2018 as well, however the data in 2018 is not available from the Internet, so we predict the value in both 2018 and 2019 but only keep the value of 2019. In order to make the probability distribution, we will apply FREQUENCY function again. The equidistant interval and frequency distribution is in following equation and table 4.22:

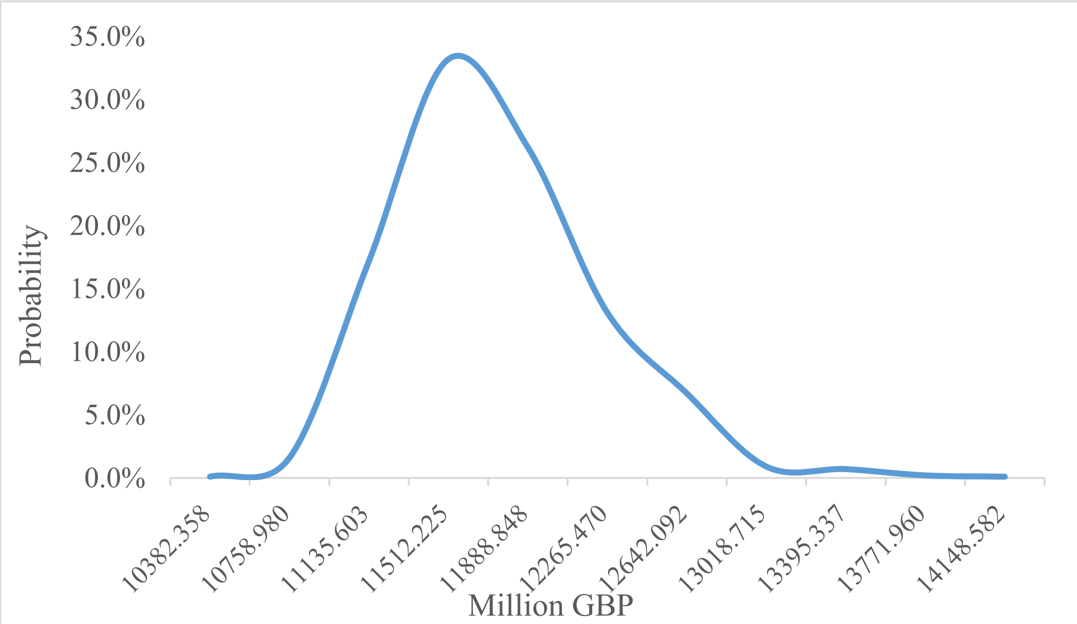
$$\text{Equidistant interval of Total cost} = \frac{14148.582\text{-}10382.358}{10} = 376.6224 \text{ Million/GBP}$$

*Table 4.22 Frequency and probability distribution of predicted Total operating cost (Million GBP)*

| | Total cost | Frequency | Probability |
|---|---|---|---|
| MIN | 10382.358 | 1 | 0.1% |
| | 10758.980 | 16 | 1.6% |
| | 11135.603 | 172 | 17.2% |
| | 11512.225 | 332 | 33.2% |
| | 11888.848 | 262 | 26.2% |
| | 12265.470 | 131 | 13.1% |
| | 12642.092 | 67 | 6.7% |
| | 13018.715 | 9 | 0.9% |
| | 13395.337 | 7 | 0.7% |
| | 13771.960 | 2 | 0.2% |
| MAX | 14148.582 | 1 | 0.1% |
| | SUM | 1000 | 100% |
| | Equidistant interval | 376.6224 | |

Based on table 4.22, the most frequent interval of total cost is 11135.603 to 11512.225 million GBP. The last step is to make our result graphically in following Figure 4.13.

*Figure 4.13 Probability distribution of predicted Total operating cost*




According to Figure 4.13 the boundary value (Top of the line) is between 11135.603 and 11512.225 million GBP, it plays as the "Watershed" in the chart and placed our line mostly in the left side, after crossing this top, the probability of total cost started decreasing. The predicted total cost value gathered mostly in the range of lower to medium level.

## 4.4 Net operating profit estimation of British Airways

According to the result of predicted total operating revenue and total cost from chapter 4.2 and 4.3, we can estimate the net operating profit of British Airways in 2019. Firstly we will analyse the historical data of net operating profit from 2013 to 2017 in table 4.23. Generally, Net operating profit is given as:

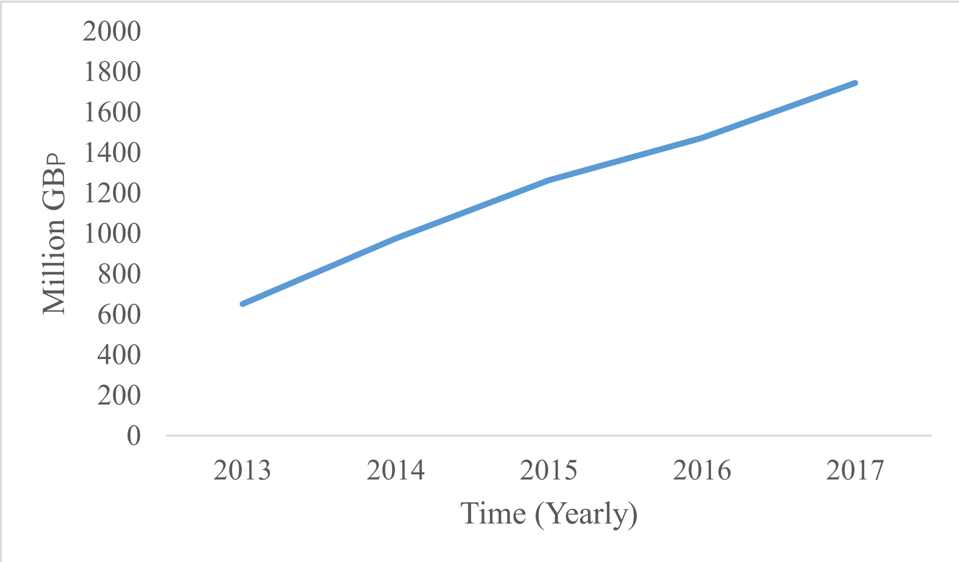
$$\mathrm{NOP}_t = \mathrm{R}_t - TOC_t \tag{4.10}$$

*Table 4.23 Historical Net operating profit from 2013 – 2017*

| *Million GBP* | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Operating profit | 651 | 975 | 1264 | 1473 | 1744 |

In equation (4.10) $\mathrm{NOP}_t$ is Net Operating profit in given time "t". Table 4.23 shows the historical value of net operating profit among years, we can find that the value of net operating profit kept increasing from 2013 to 2017, it can be a good comparison for our prediction of the profit in year 2019.

*Figure 4.14 Historical Net operating profit from 2013 – 2017*




In Figure 4.14 we can have a direct look of net profit changing. It increased quite fast from 2013 to 2015 and slowed down the speed in 2015- 2016 but keep increasing faster until 2017. Based on both table and chart, the main tendency of this company's net profit, we assume that the net profit will also increase in year 2019, the historical data help us test our prediction to be more specific. The specific equation (4.11) and table 4.24 show the result of $NOP_{2019}$.

$$\mathrm{NOP}_{2019}^{i} = \mathrm{R}_{2019}^{i} - TOC_{2019}^{i} \tag{4.11}$$

*Table 4.24 10 scenarios of Net operating profit in 2019 (Million GBP)*

| | Total operating revenue | Total operating cost | Net operating profit |
|---|---|---|---|
| S1 | 14074.3860 | 11568.5274 | 2505.8587 |
| S2 | 12139.8674 | 10830.2135 | 1309.6539 |
| S3 | 11161.3720 | 11766.3244 | -604.9524 |
| S4 | 11679.7515 | 11266.0000 | 413.7514 |
| S5 | 12297.4720 | 12000.4555 | 297.0166 |
| S6 | 12119.0282 | 11616.3484 | 502.6798 |
| S7 | 13344.0172 | 11310.3981 | 2033.6191 |
| S8 | 12705.7926 | 12324.7125 | 381.0801 |
| S9 | 13829.8644 | 12077.8107 | 1752.0537 |
| S10 | 12282.2427 | 11013.6151 | 1268.6276 |

According to the equation (4.11) we obtain corresponding 1000 net operating profit results. In table 4.24 there are 10 scenarios among 1000 sample size. Next we sort the 1000 scenarios from lowest to highest to get percentile position and statistic output.

Then we will apply FREQUENCY function as we used before to obtain frequency and probability of net operating profit. The equidistant interval and frequency distribution table are in following equation and table 4.25:

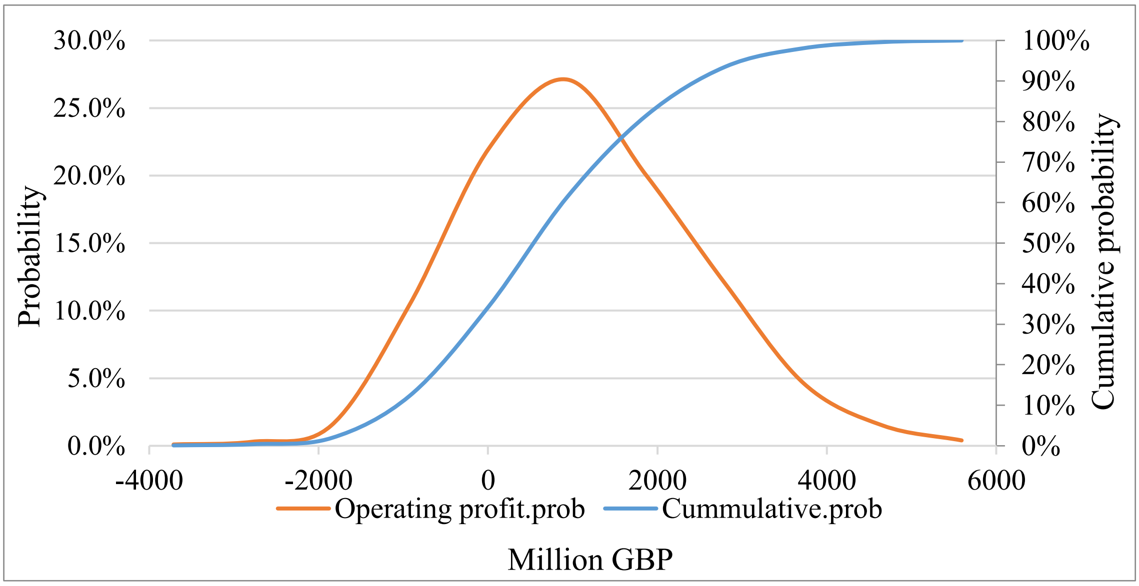
$$\text{Equidistant interval of } NOP_{2019} = \frac{5591.554\text{-}(\text{-}3712.541)}{10} = 930.4096 \text{ Million/GBP}$$

*Table 4.25 Frequency and probability distribution of predicted Net operating profit (Million GBP)*

| | Net operating profit | Frequency | Probability | Cumulative probability |
|---|---|---|---|---|
| MIN | -3712.541 | 1 | 0.1% | 0.1% |
| | -2782.132 | 3 | 0.3% | 0.4% |
| | -1851.722 | 15 | 1.5% | 1.9% |
| | -921.313 | 105 | 10.5% | 12.4% |
| | 9.097 | 220 | 22.0% | 34.4% |
| | 939.507 | 271 | 27.1% | 61.5% |
| | 1869.916 | 200 | 20.0% | 81.5% |
| | 2800.326 | 120 | 12.0% | 93.5% |
| | 3730.735 | 46 | 4.6% | 98.1% |
| | 4661.145 | 15 | 1.5% | 99.6% |
| MAX | 5591.554 | 4 | 0.4% | 100.0% |
| | SUM | 1000 | 100% | |
| | Equidistant interval | 930.4096 | | |

According to table 4.25 the equidistant interval is 930.4096 which is divided by 10 interval, the most frequent net operating profit interval is between 9.097 and 939.507 million GBP which also has the biggest probability proportion of cumulative probability changing. Comparing with the frequency table of total revenue and total cost in table 4.13 and 4.22, both of their high frequent value distributed in lower and middle range. As for Net operating profit, the high frequent value range are basically in the middle range without extreme deviation. The following Figure 4.15 shows the probability distribution and cumulative probability distribution of Net operating profit.

*Figure 4.15 Probability distribution and cumulative probability distribution of predicted Net operating profit*




In Figure 4.15 we combine probability distribution and cumulative probability distribution line to analyse Net operating profit. The ordinary line distributed almost in the middle where median line is in the right side and close to 0.And most of the probability has positive value. As for cumulative line, both ends of this line are quite flat which is almost parallel to the X axis, from Figure 4.15 almost 30% of NOP are negative, the rest of 70% have positive value. The historical value in table 4.23 can also be a good reference for us to predict net operating profit in a relatively approximate distribution interval. The characteristic of our predicted NOP can be shown in table 4.26.

*Table 4.26 Statistic output of Net operating profit in 2019 (Million GBP)*

| Net Operating profit (2019) | |
|---|---|
| Mean | 624.668 |
| Median | 535.372 |
| ST.DEV | 1369.559 |
| MIN | -3712.541 |
| MAX | 5591.554 |
| 2,5% Percentile | -1747.424 |
| 97,5% Percentile | 3578.690 |

In table 4.26 we got the statistic output of predicted net operating profit in estimated year, the minimum profit is negative which is nonsense to us, the maximum profit is 5591.554 million GBP.

## 4.5 Sensitivity analysis

The last part is about the sensitivity analysis of net profit involved with two main variables: Jet Fuel and Passengers carried. Here we will change the parameter mean value (α) which represents the speed of the version for both variables respectively within -40% and +40% to estimate the changing of net profit and the sensitivity of net operating profit with such two variables.

### 4.5.1 Sensitivity analysis of Jet Fuel changing

Firstly we assume the drift α in Jet Fuel market price could be +/- 40% from established value, after that we got two different value of α which can be shown in table 4.27 and computation process as follows:

$$\text{Original } \alpha = 0.0019$$

$$\alpha^{+} = 0.0019 \cdot 0.6 = 0.0012$$

$$\alpha^{-} = 0.0019 \cdot 1.4 = 0.0027$$

*Table 4.27 Mean value α of Jet Fuel market price in different percentage changing*

| α | △-40% | △0% | △+40% |
|---|---|---|---|
| Percentage | 0.12% | 0.19% | 0.27% |

In table 4.27 those value are quite small but it may have big impact on net profit. Within such changes of mean value, we obtained new 1000 scenarios of net operating profit on the same way as we did in chapter 4.4. In following table 4.28 is the results of NOP in Jet Fuel with different value *α*.

*Table 4.28 10 scenarios of net operating profit in Jet Fuel α change (Million GBP)*

| Scenarios/$\alpha$ | △-40% | △0% | △+40% |
|---|---|---|---|
| S1 | -3601.40201 | -3712.5413 | -3826.9591 |
| S2 | -3574.97847 | -3651.3391 | -3729.9094 |
| S3 | -3478.25673 | -3552.3206 | -3628.4719 |
| S4 | -2740.13796 | -2817.4952 | -2897.0452 |
| S5 | -2602.45580 | -2669.5634 | -2738.5720 |
| S6 | -2423.11523 | -2499.3934 | -2577.8450 |
| S7 | -2312.21817 | -2395.5787 | -2493.6681 |
| S8 | -2300.22768 | -2382.2096 | -2454.0948 |
| S9 | -2285.16674 | -2344.9762 | -2406.3893 |
| S10 | -2208.47865 | -2268.7565 | -2330.6816 |

In table 4.28 the value of each column is already sorted from lowest to highest, we can find that value of net operating profit in column △-40% is totally higher than corresponding value in column △0% and △+40%, column △+40% has the lowest value among this figure. This can also prove the reality when the cost decreased, the revenue stay the same and the net profit increased. On the contrary, if cost is higher than before when revenue is fixed, the lower net profit we will obtain.

Further we apply FREQUENCY function as we did in previous chapter to make the table: frequency distribution. Firstly we make the table with $\alpha$ in △-40%.The equidistant interval and results are in following equation and table 4.29:

$$\text{Equidistant interval} = \frac{5638.0863\text{-}(\text{-}3601.4020)}{10} = 923.9488 \text{ Million GBP}$$

*Table 4.29 Frequency and probability distribution of predicted Net operating profit (Million GBP)*

| △-40% | Net operating profit | Frequency | Probability | Cumulative probability |
|---|---|---|---|---|
| MIN | -3601.4020 | 1 | 0.1% | 0.1% |
| | -2677.4532 | 3 | 0.3% | 0.4% |
| | -1753.5043 | 17 | 1.7% | 2.1% |
| | -829.5555 | 107 | 10.7% | 12.8% |
| | 94.3933 | 224 | 22.4% | 35.2% |
| | 1018.3422 | 267 | 26.7% | 61.9% |
| | 1942.2910 | 196 | 19.6% | 81.5% |
| | 2866.2398 | 122 | 12.2% | 93.7% |
| | 3790.1887 | 46 | 4.6% | 98.3% |
| | 4714.1375 | 13 | 1.3% | 99.6% |
| MAX | 5638.0863 | 4 | 0.4% | 100.0% |
| | SUM | 1000 | 100% | |
| | Equidistant interval | 923.9488 | | |

In table 4.29 we change α with -40%, the equidistant interval is 923.9488 which is divided by 10 interval. The most frequent interval is between 94.3933 and 1018.3422 million GBP which is in the middle of these intervals and stand in the biggest proportion of probability. Next we'll increase α with +40% with new frequency distribution. The equidistant interval and results are in following equation and table 4.30:

$$\text{Equidistant interval} = \frac{5543.7112\text{-}(-3826.9591)}{10} = 937.0670 \text{ Million GBP}$$

*Table 4.30 Frequency and probability distribution of predicted Net operating profit (Million GBP)*

| △+40% | Net operating profit | Frequency | Probability | Cumulative probability |
|---|---|---|---|---|
| MIN | -3826.9591 | 1 | 0.1% | 0.1% |
| | -2889.8921 | 3 | 0.3% | 0.4% |
| | -1952.8251 | 14 | 1.4% | 1.8% |
| | -1015.7580 | 103 | 10.3% | 12.1% |
| | -78.6910 | 213 | 21.3% | 33.4% |
| | 858.3760 | 275 | 27.5% | 60.9% |
| | 1795.4431 | 200 | 20.0% | 80.9% |
| | 2732.5101 | 126 | 12.6% | 93.5% |
| | 3669.5771 | 46 | 4.6% | 98.1% |
| | 4606.6441 | 14 | 1.4% | 99.5% |
| MAX | 5543.7112 | 5 | 0.5% | 100.0% |
| | SUM | 1000 | 100% | |
| | Equidistant interval | 937.0670 | | |

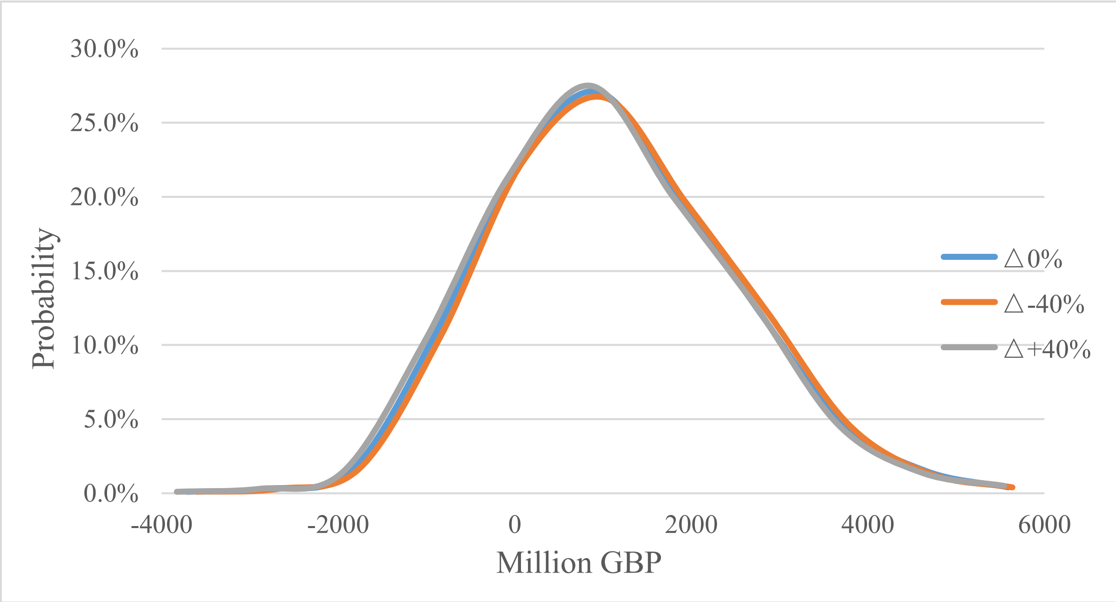
According to table 4.30 the value with α in +40%, the equidistant interval is 937.0670, the most frequent interval is between -78.6910 and 858.3760 which also stands in the middle among intervals. The results of three most frequent interval with different drift $\alpha$ is in following table 4.31.

*Table 4.31 Three most frequent interval in different $\alpha$*

| $\alpha$ | △-40% | △0% | △+40% |
|---|---|---|---|
| Interval | 94.3933~1018.3422 | 9.097~939.5066 | -78.6910~858.3760 |

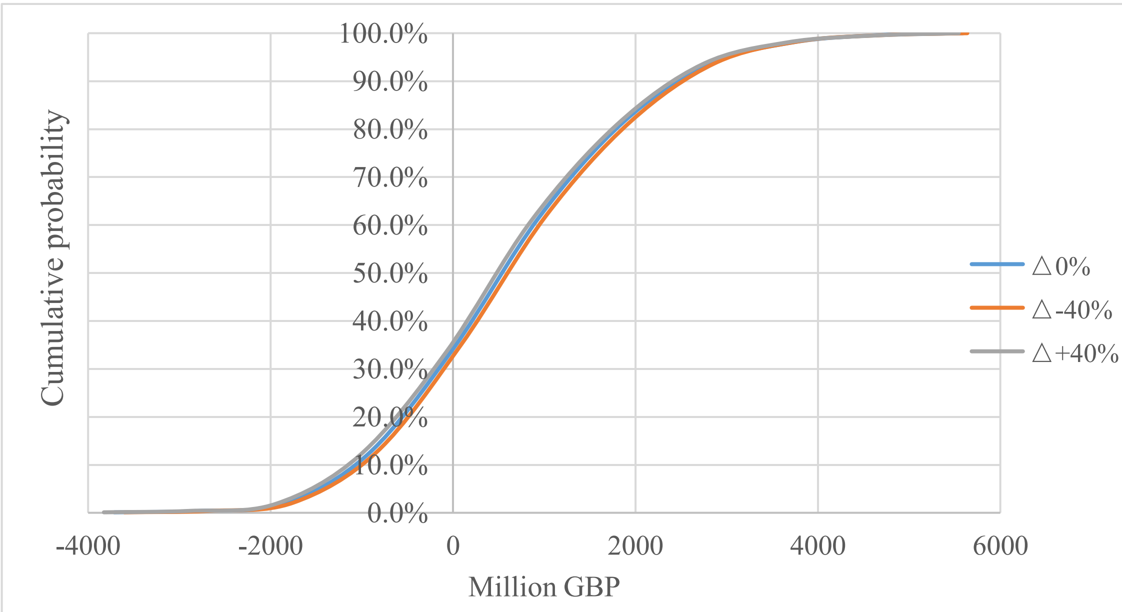
We collect three most frequent interval of net profit frequency in Jet Fuel with different α to compare the value distance in table 4.31. The upper value of the interval between △-40% and original one is 78.8356, the upper value of the interval between original and △+40% is 81.1306, and these two values are quite close. Coincidentally, all of them are in the middle of their interval column. The following Figure 4.16 is the sensitivity of Net profit in Jet Fuel market price change with different drift $\alpha$.

*Figure 4.16 Probability distribution of predicted Net operating profit in JFP change*




The last step is to make our data graphically. In Figure 4.16 these three lines are almost overlapping, as we already analysed the data before, there is no big differences among their value. Nonetheless, we can still catch some slight difference, here we regard the original line as standard, line △-40% stays more on the right side than others, line △+40% stays more on the left side. The following Figure 4.17 shows the sensitivity of Net profit in Jet Fuel market price with cumulative probability.

*Figure 4.17 Cumulative probability distribution of predicted Net operating profit in JFP change*




In Figure 4.17 we apply the cumulative probability to observe. This figure has similar line connection with Figure 4.16. The △-40% line is in the bottom, the △+40% stays on the top though it's not easy to detect due to the small difference. These lines are steeper in the middle and become flat on both ends it tells that most of the probability distribution is in the middle value interval. The relationship between such lines in the figure are consistent with the theory of cost and net profit, but the overlapping also tells that the net operating profit is not quite sensitive with the change of Jet Fuel market price. In other words, the change of Jet Fuel price can't influence our net operating profit a lot. Especially we use 40 percent change of $\alpha$ which ought to have big change. The following table 4.32 shows the characteristic of our predicted NOP result.

*Table 4.32 Statistic output of predicted net operating profit (Million GBP)*

| Net Operating profit(△Jet fuel) | | | |
|---|---|---|---|
| | △-40% | △0% | △+40% |
| Mean | 679.236 | 624.668 | 568.607 |
| Median | 591.242 | 535.372 | 472.853 |
| ST.DEV | 1365.910 | 1369.559 | 1373.420 |
| MIN | -3601.402 | -3712.541 | -3826.959 |
| MAX | 5638.086 | 5591.554 | 5543.711 |
| 2,5% Percentile | -1692.457 | -1747.424 | -1803.881 |
| 97,5% Percentile | 3622.795 | 3578.690 | 3521.822 |

As we mentioned in the beginning of this chapter, we only adjust α in historical Jet Fuel market price, the only difference is that one is in negative change the other is in positive change. As a consequence, for example in the row of Mean in table 4.32, it shows that lower drift α in Jet Fuel means higher NOP, higher drift α in Jet Fuel made higher NOP.

### 4.5.2 Sensitivity analysis of Passengers carried changing

In this part we will change drift α in historical Passengers carried on +/- 40% from established value to analyse the sensitivity of net operating profit with the same step in Jet Fuel price which can be shown in table 4.33 and computation process as follows:

$$\text{Original } \alpha = 0.022$$

$$\alpha^{+} = 0.022 \cdot 0.6 = 0.013$$

$$\alpha^{-} = 0.022 \cdot 1.4 = 0.031$$

*Table 4.33 Mean value α of Passengers carried in different percentage changing*

| △-40% | △0% | △+40% |
|---|---|---|
| 1.3% | 2.2% | 3.1% |

The computation process and result of new α is shown in table 4.33. All of these mean value in table 4.33 is much higher than Jet Fuel. Then we arrange the table of new 1000 scenarios for net operating profit in the table below.

*Table 4.34 10 scenarios of net operating profit in Passengers carried α change (Million GBP)*

| Scenarios/*α* | △-40% | △0% | △+40% |
|---|---|---|---|
| S1 | -4194.4824 | -3712.5413 | -3215.5297 |
| S2 | -4062.3352 | -3651.3391 | -3201.2096 |
| S3 | -3968.6030 | -3552.3206 | -3110.9592 |
| S4 | -3281.9671 | -2817.4952 | -2324.8522 |
| S5 | -3115.7726 | -2669.5634 | -2196.3983 |
| S6 | -2974.9713 | -2499.3934 | -1994.8994 |
| S7 | -2914.3446 | -2395.5787 | -1878.0241 |
| S8 | -2857.8131 | -2382.2096 | -1858.2410 |
| S9 | -2803.9007 | -2344.9762 | -1845.5863 |
| S10 | -2738.1705 | -2268.7565 | -1780.5738 |

In table 4.34 we sorted those value from lowest to highest, the value in column △-40% is totally lower than corresponding value in column △+40% which is opposite to the scenarios in Jet Fuel. However it is also suitable to the economic theory. Passengers carried can bring benefits, if the Passengers carried increased when cost is relatively fixed, our revenue and net operating profit will increase as well. The Passengers carried is proportional to net operating profit where Jet Fuel market price is inversely proportional to net operating profit due to economy theory.

Subsequently we apply FREQUENCY function with the same steps as before to make frequency distribution table for net operating profit. Firstly we make the table with *α* in △-40%. The equidistant interval and frequency distribution can be shown in following equation and table 4.35:

$$\text{Equidistant interval} = \frac{4721.3394-(-4194.4824)}{10} = 923.9488 \text{ Million/GBP}$$

*Table 4.35 Frequency and probability distribution of predicted Net operating profit (Million GBP)*

| △-40% | Net operating profit | Frequency | Probability | Cumulative probability |
|---|---|---|---|---|
| MIN | -4194.4824 | 1 | 0.1% | 0.1% |
| | -3302.9002 | 2 | 0.2% | 0.3% |
| | -2411.3180 | 14 | 1.4% | 1.7% |
| | -1519.7359 | 97 | 9.7% | 11.4% |
| | -628.1537 | 214 | 21.4% | 32.8% |
| | 263.4285 | 275 | 27.5% | 60.3% |
| | 1155.0107 | 202 | 20.2% | 80.5% |
| | 2046.5928 | 126 | 12.6% | 93.1% |
| | 2938.1750 | 50 | 5.0% | 98.1% |
| | 3829.7572 | 14 | 1.4% | 99.5% |
| MAX | 4721.3394 | 5 | 0.5% | 100.0% |
| | SUM | 1000 | 100% | |
| | Equidistant interval | 923.9488 | | |

In table 4.35 the equidistant interval is 923.9488, the most frequent interval is -628.1537 to 263.4285 which stands in the middle of these intervals. After that we continue apply the FREQUENCY function on the data of Passengers carried $\alpha$ with △+40% change. The equidistant interval and frequency distribution can be shown in following equation and table 4.36:

$$\text{Equidistant interval} = \frac{6515.3518-(-3215.5297)}{10} = 973.0882 \text{ Million/GBP}$$

*Table 4.36 Frequency and probability distribution of predicted Net operating profit (Million GBP)*

| △+40% | Net operating profit | Frequency | Probability | Cumulative probability |
|---|---|---|---|---|
| MIN | -3215.5297 | 1 | 0.1% | 0.1% |
| | -2242.4416 | 3 | 0.3% | 0.4% |
| | -1269.3534 | 18 | 1.8% | 2.2% |
| | -296.2653 | 115 | 11.5% | 13.7% |
| | 676.8229 | 221 | 22.1% | 35.8% |
| | 1649.9110 | 264 | 26.4% | 62.2% |
| | 2622.9992 | 197 | 19.7% | 81.9% |
| | 3596.0874 | 121 | 12.1% | 94.0% |
| | 4569.1755 | 43 | 4.3% | 98.3% |
| | 5542.2637 | 13 | 1.3% | 99.6% |
| MAX | 6515.3518 | 4 | 0.4% | 100.0% |
| | SUM | 1000 | 100% | |
| | Equidistant interval | 973.0882 | | |

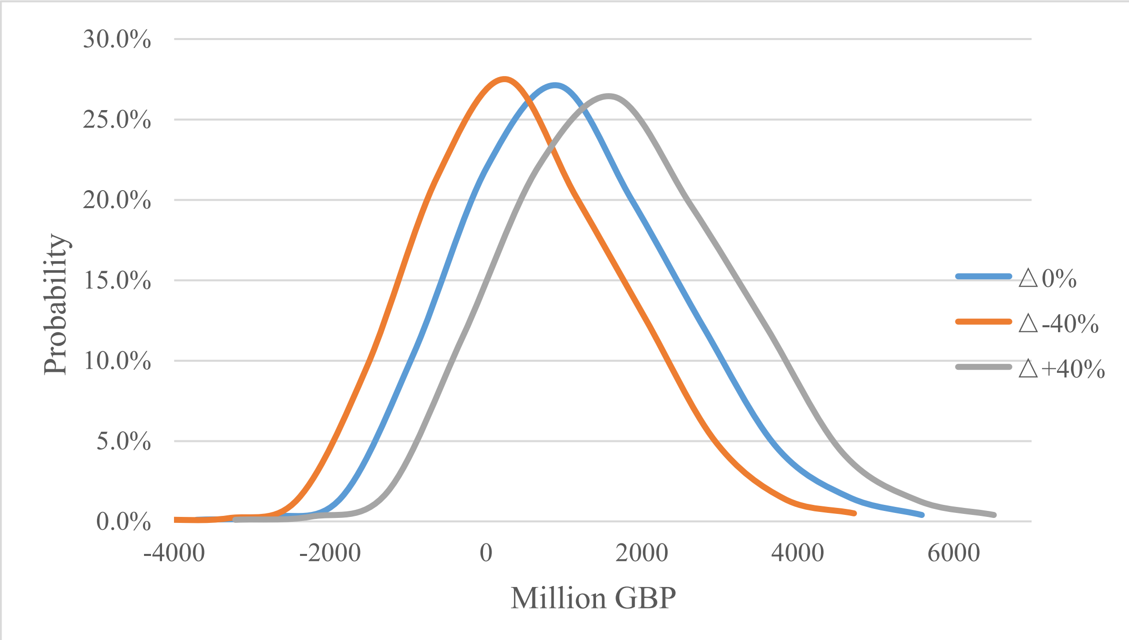
According to table 4.36 the value with α in +40%, the equidistant interval is 973.0882, the most frequent interval is between 676.8229 and 1649.9110 which also stands in the middle among all of them. The following table 4.37 shows three most frequent interval with different drift $\alpha$.

*Table 4.37 Three most frequent interval in different α*

| $\alpha$ | △-40% | △0% | △+40% |
|---|---|---|---|
| Interval | -628.1537~263.4285 | 9.097~939.5066 | 676.8229~1649.9110 |

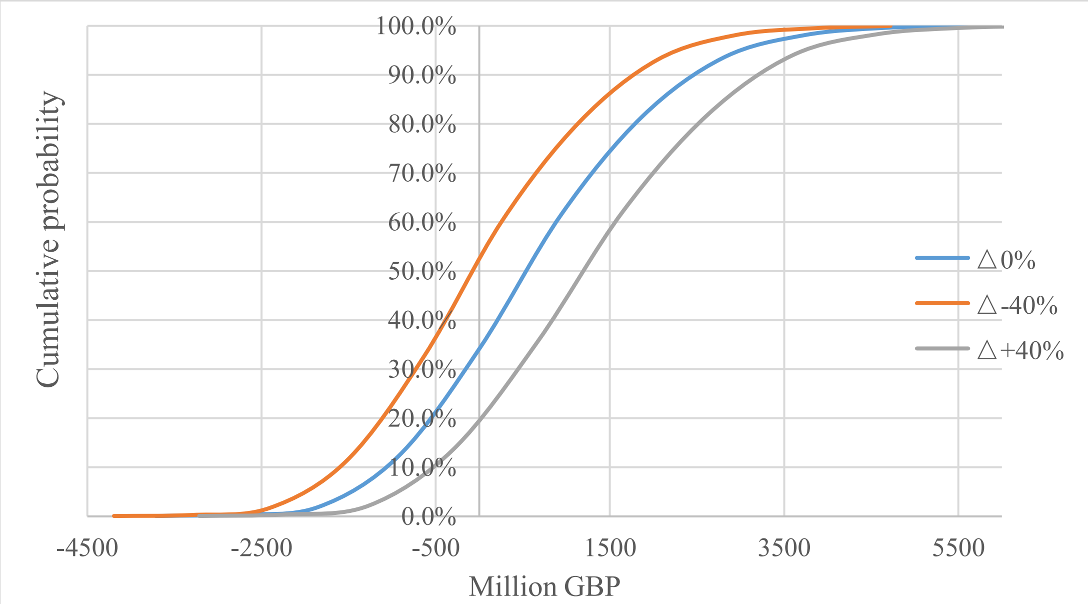
Here we also collect three most frequent value in each net profit frequency in Passengers carried α change. In table 4.37 it's easy to find that the sum of the upper value in △-40% and △+40% is nearly twice that of △0%. The following Figure 4.18 shows the Sensitivity of Net profit in Passengers carried in different drift $\alpha$.

*Figure 4.18 Probability distribution of predicted Net operating profit in PC change*




The last step it make our frequency data graphically. Different from the figure of Jet Fuel change, Figure 4.18 has quite obvious differences. These three lines are distributed in parallel with unique top. But the gap between each line is sharp contrast. Here we assume the line of △0% as the original standard. Line △-40% with highest top stays on the left side of this figure, it has lowest net profit in the same probability than others. Line △+40% has the lowest top and stays on the right side of the figure, under the same probability, it has the highest net profit value. The sensitivity of net profit in Passengers carried with cumulative probability is in following Figure 4.19.

*Figure 4.19 Cumulative probability distribution of predicted Net operating profit in PC change*




In Figure 4.19 we insert cumulative probability distribution, line △-40% stays on the top of these lines, and △+40% stays in the bottom. Based on the horizontal line we find that under the same net profit line △-40% has highest cumulative probability, but △+40% get lowest. From the side of vertical, under same cumulative probability △+40% got the highest net profit with greatly differ than the others. In the view of economic theory, when the cost is relatively fixed, the net profit increased as the total revenue go up. Based on our sensitivity test, we increased the Passengers carried to increase the total revenue, and got a significant impact on the predicted net profit. It proves that the net operating profit is sensitive with variable Passengers carried. To be more specific, the change of Passengers carried have big impact on the value of our net operating profit. The characteristic of our predicted NOP is in following table 4.38.

*Table 4.38 Statistic output of predicted net operating profit (Million GBP)*

| Net Operating profit(△Passengers carried) | | | |
|---|---|---|---|
| | △-40% | △0% | △+40% |
| Mean | 15.1537 | 624.668 | 1271.323 |
| Median | -84.1824 | 535.372 | 1167.379 |
| ST.DEV | 1300.6009 | 1369.559 | 1443.327 |
| MIN | -4194.4824 | -3712.541 | -3215.530 |
| MAX | 4721.3394 | 5591.554 | 6515.352 |
| 2,5% Percentile | -2224.6969 | -1747.424 | -1241.118 |
| 97,5% Percentile | 2800.4150 | 3578.690 | 4376.098 |

Table 4.38 shows the statistic parameters of drift $\alpha$ in Passengers carried, the value in each row has big differences, and it is on the contrary to the parameter of Jet Fuel change that each row has quite similar value. For example in the row of Mean, lower drift $\alpha$ in Passengers carried means lower NOP, if we increase the drift $\alpha$, the NOP can increase from 624 to 1271 Million GBP. Due to the base value of $\alpha$ in Passengers carried is bigger than $\alpha$ in Jet Fuel market price, it can perform a better changing for analyse.

# 5. Conclusion

British Airways is one of the world's leading global premium airlines, we choose it as our target Corporation and apply the CorporateMetrics Methodology to estimate the net operating profit of this company in predicted year 2019 under three different levels of market risks: Jet Fuel market price, Passengers carried and Exchange rate USD/GBP.

In theoretical part of chapter 2 and chapter 3, we collect data from the report of British Airways. According to the income statement of British Airways from 2013 to 2017, we find that the net operating profit is increasing steadily among these time period, although there are some weakness and threats from external environment, as a fully experienced company, British Airways keeps transforming to adapt to the market and facing challenges.

In practical part of chapter 4 based on historical trend, Jet Fuel market price and Passengers carried were increasing, the Exchange rate USD/GBP is fluctuate around a long-term equilibrium line in 1.319 USD/GBP. So we applied Geometric Brownian motion in Jet Fuel market price and Passengers carried, Exchange rate USD/GBP is applied by Vašíček model, the other relatively stable components are predicted by weighted average method and simple average method. Within computed parameters and simulation of 1000 scenarios of each variable, we find that estimated total revenue has most frequent results in 10321.5451 to 11135.2025 million GBP, where total cost is in 11135.603 to 11512.225 million GBP, and net operating profit has high frequent between 9.097 and 939.507 million GBP, however the net operating profit in 2017 is 1744 million GBP.

In the end, we make the sensitivity analysis by changing the drift α in Jet Fuel price and Passengers carried, we find that the net operating profit is more sensitive with the Passengers carried, and less sensitive with the change of Jet Fuel price. Passengers carried had increased in last 7 years, according to our estimation, we believe there is a big probability of increasing for it in 2019 with small percentage. Although the Fuel cost decreased these years, but the total cost is still increasing, and the Exchange rate of USD/GBP only has slight fluctuation.

Under such different levels of market risks, we think British Airways has high probability to generate positive net operating profit in 2019 but it won't increase a lot.

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# List of Abbreviations

| | |
|---|---|
| EaR | Earnings at risk |
| EPSaR | Earnings-per-share-at-Risk |
| CFaR | Cash-Flow-at-Risk |
| GBM | Geometric Brownian motion |
| BA | British Airways |
| IAG | International Airlines Group |
| GBP | Great Britain Pound |
| USD | United States Dollars |
| JFP | Jet Fuel price |
| PC | Passengers carried |
| ER | Exchange rate |
| R | Revenue |
| Q | Quantity |
| W | Weight |
| P | Air ticket Price |
| GAL | Gallon |
| FC | Fuel cost |
| AFP | Average fuel price |
| TOC | Total operating cost |
| OOC | Other operating cost |
| NOP | Net operating profit |

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谈灵颉 Lingjie Tan
…………………………………………………………

Student´s name and surname

# List of Annexes

# Annexes

| Million GBP | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| CONTINUING OPERATIONS | | | | | |
| Passenger revenue | 10129 | 10452 | 10164 | 10340 | 11011 |
| Cargo revenue | 689 | 598 | 547 | 589 | 683 |
| Traffic revenue | 10818 | 11050 | 10711 | 10929 | 11694 |
| Other revenue | 603 | 669 | 622 | 514 | 532 |
| Total revenue | 11421 | 11719 | 11333 | 11443 | 12226 |
| Operating expenses | | | | | |
| Employee costs | 2387 | 2422 | 2466 | 2440 | 2559 |
| Restructuring | 5 | 39 | 27 | 4 | 0 |
| Depreciation, amortisation and impairment | 722 | 831 | 761 | 769 | 751 |
| Aircraft operating lease costs | 85 | 80 | 113 | 159 | 223 |
| Fuel, oil and emission costs | 3755 | 3515 | 3031 | 2469 | 2537 |
| Engineering and other aircraft costs | 643 | 613 | 583 | 710 | 763 |
| Landing fees and en route charges | 790 | 787 | 792 | 877 | 930 |
| Handling charges, catering and other operating costs | 1340 | 1381 | 1255 | 1520 | 1649 |
| Selling costs | 439 | 449 | 401 | 415 | 480 |
| Currency differences | 28 | 37 | 46 | 88 | -6 |
| Accommodation, ground equipment and IT costs | 576 | 590 | 594 | 519 | 566 |
| Total expenditure on operations | 10770 | 10744 | 10069 | 9970 | 10452 |
| Operating profit | 708 | 975 | 1239 | 1389 | 1680 |
| (Losses) / gains on fuel derivatives not qualifying for hedge accounting | 17 | -37 | -121 | 34 | 0 |
| Finance costs | -176 | -141 | -147 | -145 | -106 |
| Finance income | 13 | 17 | 24 | 22 | 35 |
| Net financing expense relating to pensions | -45 | -3 | -9 | 10 | 6 |
| Retranslation of currency borrowings | 4 | -1 | -13 | -18 | -6 |
| Share of post-tax profits/(losses) in using the equity | -65 | 39 | 149 | 147 | 165 |
| Revaluation of convertible bond derivative liability | -164 | 0 | 1502 | 123 | -33 |
| Gains relating to available-for-sale financial assets | 8 | 10 | 4 | 4 | 3 |
| Profit before tax from continuing operations(EBIT) | 651 | 975 | 1264 | 1473 | 1744 |
| Tax | -16 | -157 | -120 | -221 | -297 |
| Net earnings (EAT) | 284 | 702 | 2508 | 1345 | 1447 |